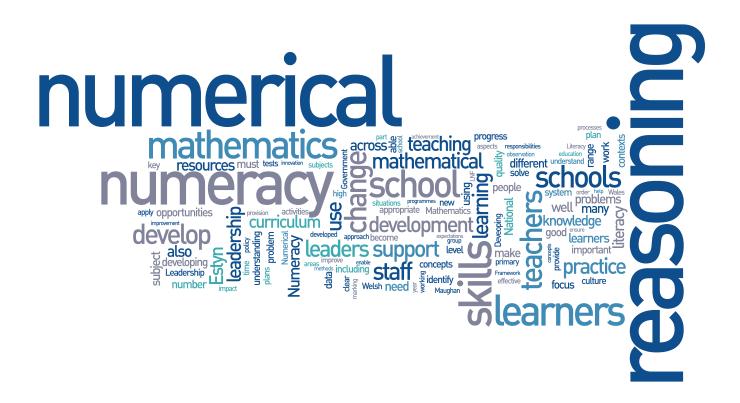








Numeracy and mathematics leaders'



These materials have been carefully developed for use in schools. We are however always grateful for suggestions about how they might be improved or the language modified to make them as accessible as possible for teachers. If you have any suggestions or comments, please send them to dmcgowan@cfbt.com

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1. Why numerical reasoning matters

Introduction

This handbook has been written for leaders of numeracy and mathematics in primary and secondary schools. A 'Leadership guide' was distributed to headteachers in spring 2014. Numeracy coordinators and mathematics leaders will want to review the *Leadership guide* as well as this handbook.

Weblinks

 The Leadership guide: http://learning.wales.gov.uk/resources/browse-all/ leadership-guide-developing-numerical-reasoning/?lang=en

1.1 Mathematics is about more than just passing examinations

Numeracy is a vital life skill. It is a proficiency developed not only in mathematics lessons but also by its use and application across the wider school curriculum. We know that learners who are confident in their use of mathematics are more likely to succeed in many areas of study beyond mathematics.

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

In all phases of education, teachers and subject leaders want the best for their learners. Of course, that includes success in examinations – but it requires more than that if learners are to succeed in an increasingly numerate world.

1.2 Learners need to become confident, independent users of mathematics

To be numerate, all learners deserve to become confident, independent users of mathematics in their schoolwork, their home lives and in the world of work. We need an approach to numeracy and mathematics education in Wales that makes that happen; and this in turn means that we need to develop learners' confidence and resilience in using their growing mathematical knowledge and understanding to solve a broad range of problems in a variety of contexts.





1.3 Teachers in Wales need to be confident of their ability to develop twenty-first century skills

At the heart of the numeracy component of the Literacy and Numeracy Framework (the LNF) is the requirement for learners to think and reason flexibly and fluently, using mathematical thinking to solve practical and real-world problems in a range of contexts. Development of this kind of thinking is of course dependent on their teachers, who need to have a thorough understanding of the use and application of mathematics, and of effective learning and teaching, if learners are to develop in this way.

This is an exciting vision, but it poses fresh challenges for teachers in Wales. Teachers need to understand the behaviours and habits of mind that learners need to develop if they are to become good problem-solvers and numerate thinkers. For example, teachers should understand that their learners need to be resilient and inquisitive, and that they need to develop a 'can-do' attitude towards mathematics and its use across the wider curriculum. This handbook, used in conjunction with the LNF, the Progression Map and other curriculum documentation and resources, will help subject leaders and numeracy coordinators to support teachers in meeting this challenge.

Section 2 of this handbook sets out the rationale for change and introduces some of the tools that can be used to aid mathematics planning, enrich teaching and strengthen assessment for learning.

Section 3 looks at how numeracy and mathematics leaders in schools can support colleagues to develop their numeracy and mathematics teaching so that learners develop numerical reasoning.

Before considering these aspects, it is worth reflecting on the scale and urgency of the challenge that we face.

1.4 How does mathematical performance in Wales compare with that of other countries?

Weblinks

- The PISA study: http://www.oecd.org/pisa/
- PISA country report on Wales: http://www.oecd.org/edu/Improving-schools-in-Wales.pdf

The PISA study, run by the United Nations' Organisation for Economic Co-operation and Development (the OECD) is the largest international comparison of educational performance in different school systems.

The latest survey, in 2012, focused on mathematics performance. Participants, who were aged 15, took a two-hour online test with questions based on six levels of proficiency. Outcomes were assigned on the PISA six-point scale, with performance below Level 2 being categorised as 'very low'. More information on the PISA performance scales can be found in the Wales country report (see link above).

The 2012 PISA mathematics results for Wales do not make for comfortable reading.

- In the 2012 UK cohort as a whole, just 55% of 15-year-olds achieved Level 3 or above.
- In itself, that figure should be a cause for concern only just over half of 15-year-olds in the UK are demonstrating a level of mathematical thinking that most employers would want to take for granted.
- In Wales, however, the figure was below that for the UK as a whole, with just 43.5% of the cohort achieving Level 3 or above.

The table below shows the percentage of 15-year-olds reaching each level, and confirms Wales' performance as the lowest in the UK. The proportion of low-performing students in mathematics (below Level 2) was 29%, which was considerably worse than the UK average (21.8%) and the OECD average (23%).

PISA 2012: Mathematics test outcomes by level, UK jurisdictions

	Below L1	L1	L2	L3	L4	L5	L6
OECD average, %	8.0	15.0	22.5	23.7	18.1	9.3	3.3
United Kingdom	7.8	14.0	23.2	24.8	18.4	9.0	2.9
England	8.0	13.7	22.8	24.5	18.7	9.3	3.1
Scotland	4.9	13.3	24.8	27.2	18.8	8.5	2.4
Northern Ireland	8.6	15.5	23.8	24.3	17.5	8.1	2.2
Wales	9.6	19.4	27.5	25.1	13.1	4.3	1.0

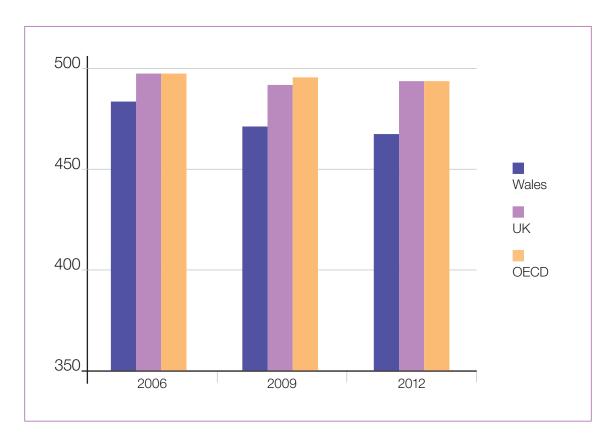
OECD, PISA 2012 Results, Volume 1

The OECD also publishes PISA test outcomes in the form of a single summary score for each subject. A similar picture emerges on this measure:

"Although Wales' performance in reading has remained similar to PISA 2006 and PISA 2009, it has decreased significantly in mathematics and science since 2006. Wales' mean performance on PISA 2012 was 468 score points in mathematics, significantly below the OECD average (494 score points) as well as below England (495), Northern Ireland (487) and Scotland (498)."

OECD, 2014, Improving Schools in Wales: An OECD Perspective, page 19

The relative decline in Welsh performance in mathematics over the last three PISA studies is shown in the chart that follows.¹



PISA mathematics scores, 2006–2012

¹ The chart is scaled to give a fair representation of the data – the lowest mathematics score from any country participating in PISA 2012 was 368.

1.5 PISA in perspective

PISA is not a narrow test of learners' ability to reproduce standard results or apply routine techniques. Instead, it aims to assess **mathematical literacy**, as described below:

"Mathematical literacy is an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens."

OECD: PISA 2015 Draft Mathematics Framework, 2 page 5

For a better idea of the kind of reasoning skills needed in the PISA tests, consider the following sample item for the 2015 survey ('zeds' are the generalised currency units used in the PISA tests):

Pizzas

A pizzeria serves two round pizzas of the same thickness in different sizes. The smaller one has a diameter of 30 cm and costs 30 zeds. The larger one has a diameter of 40 cm and costs 40 zeds.

Which pizza is better value for money? Show your reasoning.

Ibid., page 37

The PISA test addresses three fundamental mathematical processes:

- Formulating situations mathematically
- Employing mathematical facts, procedures and reasoning
- Interpreting, applying and evaluating mathematical outcomes

The sample shown was one of the more difficult PISA questions. All three of these processes are involved in the question, but the key element required is that of **formulating** a mathematical model to represent the relevant facts and relationships.

To tackle this kind of question successfully, learners need experience of selecting and using a range of mathematical approaches to make sense of and solve problems in a variety of contexts. That is what developing numerical reasoning sets out to achieve.

² PISA Draft Framework for 2015, OECD 2015; used with permission.

1.6 Defining numerical reasoning

Weblinks

- The *Leadership guide*: http://learning.wales.gov.uk/resources/browse-all/leadership-guide-developing-numerical-reasoning/?lang=en
- Qualifications Wales: http://www.qualificationswales.org/qualification-type/gcses/
- The Literacy and Numeracy Framework (LNF): http://learning.wales.gov.uk/ resources/browse-all/nlnf/?lang=en

Numerical reasoning is defined in the *Leadership guide* as follows:³

"Numerical reasoning is the process of using 'number sense' (i.e. knowing when to use a particular operation; when to use mathematics relationships; ability to monitor one's performance when computing, as example, judging reasonableness of answer with respect to an applied problem or by what one knows about numbers) which facilitates the formation of conclusions, judgements, or inferences from facts or premises in order to tackle real-world mathematical problems in a variety of situations."

In the LNF, the **Numerical reasoning** strand is broken down into three elements:

- Identify processes and connections
- Represent and communicate
- Review

The LNF provides a set of descriptions explaining what is involved in each of these elements across a stage of learning, as well as examples of relevant classroom activities. More detailed guidance for each element in each year group is provided in the Progression Map.

³ More information about the research and rationale behind the definition of numerical reasoning can be found in the research paper referenced in the *Leadership guide*.

2. Why learning and teaching need to change

2.1 Failing to reason?

Weblinks

- Sample reasoning materials: http://learning.wales.gov.uk/resources/numeracy-sample-materials/?lang=en
- Acumina report on the reasoning tests: http://learning.wales.gov.uk/docs/learningwales/publications/131128--summary-report-numeracy-test-trials-en.pdf

Section 1 of this handbook presented evidence from PISA showing that 15-yearolds in Wales are falling behind their peers in the key area of numerical reasoning. In this section, we will look more closely at the sources of this problem and identify the changes to learning and teaching that are needed.

An example from the numerical reasoning tests helps to illustrate how developing numerical reasoning is fundamental to successful problem-solving throughout the age range.

Here is question 2 from the Year 3 Reasoning sample materials.



You can buy whole pizzas or slices.

There are 8 slices in a whole pizza. It costs £5

1 slice costs £1

How much does the family pay? €_____

A successful approach to this question could be thought of in terms of the three strands within numerical reasoning.

- Identify processes and connections: in this question, learners need to make sense of the problem by understanding that the total cost is required and that it will be necessary to find the number of whole pizzas and additional slices.
- Represent and communicate: for this problem a visual representation would be appropriate and learners could draw pictures to show the number of pizzas and slices needed. They could then annotate the diagrams with numbers to show the costs, and use some sort of calculation strategy to find an answer.
- Review: for any problem, we would want learners to ask, 'Does my solution
 make sense?' Here, they should reflect on their answer in relation to the
 information in the question and their own real-life experience with money and
 shopping: does it seem reasonable? We would also want learners to develop
 checking strategies, for example performing calculations in reverse and checking
 that the same answer is obtained.

So, how successfully do learners in Wales tackle this kind of problem? The summary report on the 2013 Numeracy test trials by the test developers, Acumina (see Weblinks above), notes that the results of the trials were disappointingly low – for example a mean mark of 25% on the Year 3 test, and just 19% in Year 9.

There are clearly a number of factors underlying this poor performance, and the report provides a useful summary of these. However, the key factor to address here is that learners did poorly on this kind of test item because they had not had enough of the kind of learning experiences that would have developed their ability to use numerical reasoning skills to solve realistic problems.

"Throughout these tests, at all year groups, some children displayed a worrying lack of number sense, giving answers that made no sense within the given context. Many learners adopted an 'if in doubt, add' strategy to a wide range of problems. There was almost no evidence of checking strategies."

Acumina, Summary report on the numeracy reasoning pre-tests taken in May 2013

2.2 The need for change

Weblinks

- Revised Programme of Study: http://learning.wales.gov.uk/resources/browseall/revised-areas-of-learning-and-programmes-of-study/?skip=1&lang=en
- The Literacy and Numeracy Framework (LNF): http://learning.wales.gov.uk/ resources/browse-all/nlnf/framework?lang=en

Taken together, PISA results for Wales and evidence from our own numerical reasoning tests tell a clear story: learners in Wales can and should be doing better, and teachers in every age range and subject area have a role to play in securing the improvements that are so urgently needed.

Our key response is the Literacy and Numeracy Framework (the LNF), which sets the scene for a radical transformation of education in Wales by giving teachers in every subject, and from the Foundation Phase through to Year 9, the tools they need to support the development of literacy and numeracy for all learners. Developing numerical reasoning is central to the LNF, and is a vital part of the changes that are needed to tackle the weaknesses we have identified.

Our shared ambition to raise standards in numeracy has helped to shape the Curriculum for Wales more broadly.

- Following consultations, revised Areas of Learning and Programmes of Study were published in October 2014.
- These revisions provide greater support for the teaching of both literacy and numeracy in all areas of the curriculum.
- The Curriculum for Wales is carefully aligned with the LNF, and the numeracy components of the LNF have been incorporated into the revised Programmes of Study. The new approaches are available for teaching immediately, and will be statutory from September 2015.
- Learners will take two GCSE examinations in mathematics, with a new Mathematics – Numeracy course available for first teaching from September 2015. This new qualification will build on the levels of numeracy set out in the LNF and developed by the end of Key Stage 3.

This is a bold and ambitious vision, in which the LNF plays a central role. It sets the agenda for change by providing detailed information about the curriculum and the learning sequence that will build year-on-year from the Foundation Phase to Year 9. Together with the other developments happening across the system, the LNF defines the changes that are needed to secure a world-class education for learners in Wales.

2.3 Moving forward with numerical reasoning

While the national picture provides an important background, it is the more immediate picture in individual local authorities, communities and schools that will determine the scale and nature of the changes that teachers need to plan for.

The results of the numerical reasoning tests provide a good starting point for analysing performance at school level:

- Standardised scores from the tests provide a reliable overall measure of learner performance in numerical reasoning.
- The results analysis spreadsheet, available from Learning Wales, can be used to gain a greater insight into the performance of individual learners, checking their responses against a list of common errors and misconceptions.

Whatever your starting point, there will be some common development themes for all subject leaders or coordinators working on the development of numerical reasoning. Whether you are working across the curriculum in a primary school, or focusing on mathematics teaching or the teaching of another subject in a secondary school, you will need to think about questions such as:

- Does our current curriculum provide enough opportunity for learners to use and practise numerical reasoning? Is there too much 'spoon-feeding', or an overreliance on closed tasks and standard techniques? Do some curriculum areas avoid numerical challenges altogether?
- How do we best plan and structure lessons to support numerical reasoning?
- What are the implications for grouping, styles of teaching activities, group work, questioning, and so on?

Opportunities to develop numerical reasoning skills can arise in all subject areas. Teachers should provide experiences relating to different types of problems and contexts so that learners are encouraged to:

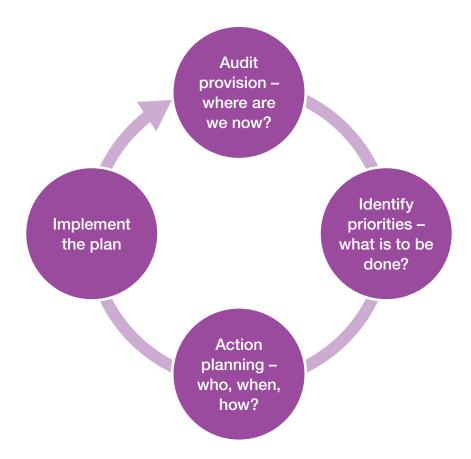
- organise and order information, deciding what is relevant and what is redundant
- ask questions such as 'What is this telling me?' 'Would it make a difference if...?'
- look for and spot patterns and relationships, and generalise from these where appropriate
- see the problem as a whole, even though the process of solving it may mean breaking it down into smaller and more manageable pieces
- recognise and appreciate that there is not necessarily one way of tackling a problem or presenting a solution, and that there is not always a single right answer
- realise that choices often have to be made and they will need to be discussed and justified using a logical or reasoned argument.

There is a lot to think about here, and priorities will depend on the details of the current position in individual schools. It is best to approach the process through a systematic approach to auditing current provision, deciding on priorities and then planning and implementing the developments required.

3. Leading change in your school or department

3.1 The improvement cycle

The process of leading change can be thought of in terms of a cycle of improvement.



3.2 Auditing

Start by **auditing current provision**. There is a range of tools available to support the auditing process, and you will find references to several approaches and tools in the *Leadership guide*.

A selection of auditing tools is provided on the following pages:

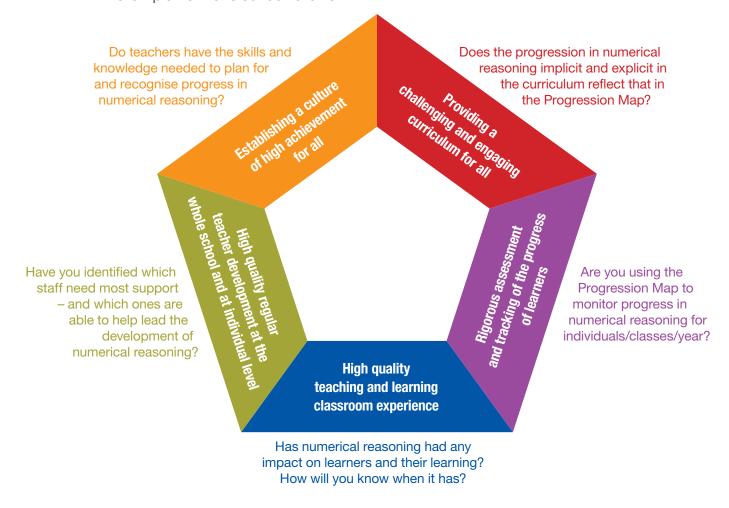
- · 'Five key levers'
- Audit questions

3.2.1 'Five key levers'

The National Mathematics Partnership (2011) set out the following **five key levers to raising achievement in mathematics:**

- 1. Establishing a culture of high achievement for all
- 2. Providing a challenging and engaging curriculum for all
- 3. Rigorous assessment and tracking of the progress of learners
- 4. High quality learning and teaching classroom experience
- 5. High quality regular teacher development at whole-school and individual levels

Drawing up your own questions to be answered for these five features is a good starting point for auditing your current provision in developing numerical reasoning. An example from one school follows:





You will note that this diagram and subsequent text refers to the Progression Map. The Progression Map is an interactive, online resource which has been developed to provide a detailed articulation of numerical reasoning and how the skills and knowledge develop year-by-year from the beginning of the Foundation Stage to the end of Key Stage 3. As such, it is a very comprehensive resource which includes links to supporting materials and activities for each of these year groups.

On the following pages, you will find the full text of each of the numbered points above in the form of a series of bullet points. We also provide some suggested questions that you can usefully address in developing numerical reasoning in your school. As the numeracy and/or mathematics leader for your school, you could go through each grid, using it as an audit tool to evaluate your current provision. A box at the bottom of each grid is provided for you to note down any comments and issues relating to each 'key lever'. Of course, you may already have an equivalent auditing process in place, in which case you may wish to incorporate the key points from the material that follows into your own model.

Key lever 1: Establishing a culture of high achievement for all

Full text	Questions
A belief that high achievement in mathematics is possible and should be the aim for all learners when they leave the school.	 Are teachers aware of the expectations for numerical reasoning in the LNF and the Progression Map? Do they believe that they are realistic?
SLT provides the strategic aspiration; the numeracy/ mathematics leader embodies it.	 Have the school's senior leaders communicated the importance of numerical reasoning to the whole staff? If not, how will you help them to do this?
An unwavering focus on the progress of learners – collectively and individually – expecting that all learners should achieve at least the expectation for their year group from the moment they enter the school to when they leave.	Do teachers have the skills and knowledge needed to plan for and recognise progress in numerical reasoning?
The school will not give up on any learner, no matter how challenging and time consuming they are.	Do all teachers have an expectation that numerical reasoning is for all learners not just the more able or the more willing?

- What resources do I have or need, to evaluate and act on the above points?
- Do I need a timeline to action these points?

Key lever 2: Providing a challenging and engaging curriculum for all

Full text	Questions
The curriculum is well structured with clear and ambitious aspirations for all learners.	Does the progression in numerical reasoning that is implicit and explicit in the curriculum reflect the pitch and progression of the examples in the Progression Map?
 The curriculum builds in problem- solving and using/applying mathematics as well as all the required concepts, skills and understanding. 	Is numerical reasoning a 'bolt-on', or an integral part of the curriculum?
The medium-term plans support teachers in maintaining high expectations.	Do your medium-term (unit) plans identify targets for numerical reasoning?
There are minimum expectations for each year group that enable achievement of at least the expectation for their age group for all learners, and higher than this for many.	Do your long-term plans identify targets for numerical reasoning?

- What resources do I have or need, to evaluate and act on the above points?
- Do I need a timeline to action these points?

leaders' handbook

Key lever 3: Rigorous assessment and tracking of the progress of learners

Full text	Questions
 There is regular monitoring of the progress of all and timely response/intervention established for those falling off the expected trajectory. 	 Are you using the Progression Map and learners' data (including the results of numerical reasoning Tests) to monitor progress in numerical reasoning for individuals/classes/year groups?
Identified strategies and programmes are in place for intervention and support, aimed at getting back on track those falling behind.	 What resources or approaches are you going to use for specific intervention around numerical reasoning? How will you reduce the need for 'catch-up' intervention over time?
All learners are set ambitious targets and are supported in striving towards them.	 Have you used the Progression Map to facilitate target setting? Do learners know and understand their numerical reasoning targets?

- What resources do I have or need, to evaluate and act on the above points?
- Do I need a timeline to action these points?

Key lever 4: High quality learning and teaching classroom experience

Full text	Questions
Learning is the priority, rather than teaching, with a sharp focus on the learners, their engagement and the progress they make.	 Has numerical reasoning had any impact on learners and their learning? How will you know when it has?
Good practice is sought, identified and shared – developed with external input where necessary.	Who are your 'champions' for numerical reasoning? How are you using and sharing their expertise?
	 If necessary, have you brought in external support?

- What resources do I have or need, to evaluate and act on the above points?
- Do I need a timeline to action these points?

Key lever 5: High quality regular teacher development at whole-school and individual levels

Full text	Questions
Regular staff meetings focus on learning and teaching issues in mathematics and sharing developing practice.	 Has numerical reasoning been the focus for a staff meeting? What are the priorities for development (short-, medium- and long-term), and have these been incorporated into the School Development Plan?
The school is a 'learning organisation' and engages in effective professional learning for mathematics, including action research, sharing practice and coaching or mentoring.	 Have you identified which staff need most support – and which ones are able to help lead the development of numerical reasoning? What structures (e.g. coaching or mentoring programmes) are in place to facilitate this?
Debate and development about the pedagogy of the classroom is facilitated through whole-school professional learning and at individual level.	 Have mathematics teachers had the opportunity to discuss the importance of numerical reasoning? Are they convinced? Have you reviewed and evaluated the impact of professional learning?

- What resources do I have or need, to evaluate and act on the above points?
- Do I need a timeline to action these points?

3.2.2 Audit questions

Another useful resource to support auditing current provision is Estyn's list of questions for subject leaders on literacy and numeracy, reproduced in Appendix 4 of the *Leadership guide*. Adapting the questions from that guide to focus on numerical reasoning produces the following list.

Audit question	Response
What is your view of standards in numerical reasoning in the school?	
How much difference are you making to learners' progress and development?	
How do you plan to raise standards in numerical reasoning?	
How do you identify and map skills and develop them progressively?	
What is the impact of the school's numerical reasoning approaches in helping learners develop skills systematically, over time and in a broad range of contexts?	

What factors are preventing learners developing good numerical reasoning skills?	
Do you know how well learners are progressing, including those receiving targeted support or extension?	
How do you identify the learners who need support to improve their numerical reasoning skills?	
How do you ensure that all staff teach the many concepts and methods with consistency?	
How do you review and evaluate the impact of numerical reasoning initiatives?	
What are you doing to improve the development of learners' skills during transition?	
What professional learning do you provide for support staff, learning coaches and peer buddies so there is a consistent approach to the development of learners' skills?	

3.3 Action planning

Weblinks

- The Leadership guide: http://learning.wales.gov.uk/resources/browse-all/ leadership-guide-developing-numerical-reasoning/?lang=en
- Reasoning in the Classroom materials: http://learning.wales.gov.uk/ learningpacks/reasoning-in-the-classroom/?lang=en
- Estyn guidance on numeracy: http://www.estyn.gov.uk/english/ docViewer/1501.5/improving-numeracy-in-key-stage-2-and-key-stage-3april-2010/?navmap=30,163,

3.3.1 Agreeing priorities

Before moving on to drafting your action plan, it is important to prioritise the possible actions arising from the audit. This is an important part of the process, and easily overlooked; agreeing a manageable set of priorities can make the difference between a workable action plan and an unstructured 'wish list' that does not lead to real change.

Aim for 'bite-sized chunks' that will lead to visible improvements, and group related actions together within a clear, phased plan that will allow you to build up developments over time.

3.3.2 Action planning – using the *Leadership guide*

You will probably have your own school-based processes, forms and procedures for action planning. However, you may find it easiest to start with the materials provided in the *Leadership guide*, which have been specially designed to facilitate the process of planning for developing numerical reasoning.

The Leadership guide includes:

- examples of web-based resources to support auditing and planning (pages 30–32)
- a discussion of key roles and responsibilities (page 33)
- an action planning format for numerical reasoning (Appendix 6).

An important first step towards action planning is to meet with the relevant members of your school's senior leadership team (SLT) and agree priorities by working through these sections of the *Leadership guide* and the results of your audit.

3.3.3 Action planning principles

Whichever tools and approaches you use to develop your action plan, it is important to consider the following principles:

- Remember that numerical reasoning represents a big set of changes, with profound implications for teachers' practice. Try to make it enjoyable, and remember that 'winning hearts and minds' is an important part of the process.
- Aim for some early successes that will provide clear examples of what numerical reasoning looks like. Celebrate and share these successes to build the culture for change.
- Share the vision with learners, parents and carers as well as teachers of mathematics and other subjects.
- Focus on solutions rather than problems. Identify what individual teachers can
 do (and will enjoy doing), to avoid the danger of getting 'stuck' at an initial stage
 of uncertainty or cynicism.
- What professional learning will staff need? How will this be provided?

3.4 Changing learning and teaching

3.4.1 Using the LNF and the Progression Map to support planning

"The LNF is first and foremost a curriculum planning tool that supports all teachers in embedding literacy and numeracy across the curriculum and developing the literacy and numeracy skills of their learners."

Welsh Government, 2013, Curriculum planning guidance

Schools have a range of approaches to curriculum planning and teachers can mean various things when they talk about 'plans' and 'schemes of work' in schools: they could be talking about something very broad (the whole National Curriculum) or something as specific as an a plan for an individual lesson or activity. For this reason, it is useful to consider **short-, medium- and long-term planning**.

For each of these levels of planning, teachers should be encouraged to ask questions such as:

 What opportunities are there for ... (e.g. group work and discussion, solving problems in realistic contexts)?

- What does the information from the National Numeracy Tests tell us about the strengths and development needs of cohorts? How can we plan accordingly?
- How can we ensure that there are appropriate opportunities to develop numerical reasoning in all curriculum areas, and how will we monitor this?

Together with this sort of searching question, the following points should help you to work with teachers to use the LNF and the Progression Map to develop planning at each of the three levels. Each point can form the basis for a discussion, usually just by asking 'Is this happening?' or 'How can we make this happen?'

Long-term planning

- Long-term plans typically set out an overview of the teaching to take place over a year, often broken down into a series of units of work. The LNF supports longterm planning by setting out the broad sweep of progression for each strand, across year groups.
- The Progression Map adds detail, providing examples that 'bring to life' the more generic descriptions of numerical reasoning in the LNF. For example, the Progression Map might show how a certain image is helpful for building a particular concept (or perhaps that it will be helpful later).
- Together, these tools make it easier to identify clear expectations for numerical reasoning across year groups and subjects. For example, learners' use of numerical reasoning in Year 9 should look and feel different to that in Year 7 and not just because of the difference in their mathematical experience and expertise. The older learners should be demonstrating greater independence, resilience and confidence in using numerical reasoning to solve problems, and yearly plans need to reflect and enable this development.

Medium-term planning

- Medium-term planning usually means producing a series of units of work, with each unit covering a particular topic. The LNF and Progression Map can clearly support this aspect of planning as well.
- Teachers could usefully think about the statements in the Progression Map as outcomes, and then consider implications for unit planning. They need to ask themselves: 'If I want my learners to be able to think, reason and analyse like this, what learning and teaching opportunities do I need to provide in this unit of work, and what experiences do I need to organise?'

 Teachers need to think about the progression in numerical reasoning between units (long-term planning) and within a unit (medium-term planning). So, when planning or reviewing a unit of work, one good question would be: 'What opportunities are there to develop learners' confidence and independence in numerical reasoning?'

Short-term planning

- This is essentially lesson planning. At this level, we are often looking at the quality of an individual approach or activity, rather than considering progression.
- The Progression Map is still very helpful, as it provides the pitch and expectation required for the age group and serves as a good indicator of the kind of approaches that we want learners to engage with.
- Teachers may find it helpful to review a selection of lesson plans in relation to the examples in the Progression Map. Are there sufficient, regular opportunities for learners to make independent mathematical decisions, to follow their own lines of enquiry, be required to reason and sense-make and so on? Or is there too much direction or spoon-feeding?

3.4.2 Strengthening teaching

Focus on numeracy in all subjects - not just mathematics

A growing range of materials is available to support the development of numerical reasoning in subjects across the curriculum. For example, the 'Reasoning in the Classroom' materials available on Learning Wales (see Weblinks) cover a range of curriculum contexts and you should incorporate these wherever they are appropriate.

In working to identify opportunities for developing numerical reasoning across the curriculum, you may find it useful to refer to Estyn's wider guidance on numeracy across the curriculum (see Weblinks). In section 3.2.2, we developed some audit questions by taking a list of questions about numeracy and substituting numerical reasoning throughout. Adopting the same procedure to the Estyn guidance document referred to above produces the following text:

Primary schools

In most primary schools, the same teacher teaches mathematics and other subjects. This teacher is aware of the level of learners' **numerical reasoning** skills and can identify appropriate opportunities to use these skills in other subjects. Primary schools with good standards of **numerical reasoning** make sure that learners apply their **numerical reasoning** skills well in a range of situations.

Many of these schools identify the **numerical reasoning** skills learners require in other subjects and help learners to cope with these demands. These schools identify opportunities for learners to reinforce and practise their **numerical reasoning** skills in these subjects. They also organise a range of whole-school projects and activity days that focus on **numerical reasoning**. These activities enable learners to improve their **numerical reasoning** skills further and also highlight the use of numerical reasoning in real-life contexts.

Secondary schools

Too few secondary schools have well-established strategies to develop learners' numerical reasoning skills across the curriculum. Many schools do not make enough use of subjects across the curriculum as practical and relevant contexts for learners to develop and apply their numerical reasoning skills. As a result, even when learners have good numerical reasoning skills, they often lack confidence in using these skills in unfamiliar contexts and other subjects. In many schools, teachers tell learners at the start of the lesson the skills that learners will use. However, many teachers in subjects across the curriculum do not take enough advantage of opportunities to practise and reinforce the skills learners have gained in mathematics lesson when appropriate ...

It is worth reflecting on these descriptions – do they accurately describe the situation in your school? This kind of broad description can provide a good prompt to review your action plan, and ensure that it includes key actions that will have an impact on the quality of learning and teaching.

3.4.3 Using the LNF and the Progression Map to support assessment

"It is intended that the LNF is used directly by practitioners for formative assessment purposes. It provides a progression framework that can be used to develop learning expectations and success criteria and, when used in conjunction with AfL practice, will embed a shared understanding of progression among practitioners and learners."

Welsh Government, 2013, Assessment for learning and the National Framework for Literacy and Numeracy

It is important to understand that the LNF and Progression Map are not designed to provide a checklist of items to be worked through or marked off; still less do they provide a basis for awarding an overall mark or level to individual learners. Instead, it is most useful to use the LNF and the Progression Map as tools to support assessment for learning by informing enquiry and dialogue in relation to learners' progress.

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Many learners have gaps in their conceptual understanding which are barriers to further learning. The LNF and the Progression Map provide a tool for teachers to track back along a pathway and teach the relevant concept from the beginning with understanding.

4. Getting support

Weblinks

- Learning Wales: www.learningwales.gov.uk
- National Support Programme (NSP): http://learning.wales.gov.uk/ learningpacks/mep/numeracy/contexts-for-learning-and-teaching/thenational-support-programme/?lang=en
- Regional consortia: http://learning.wales.gov.uk/news/sitenews/schoolimprovement-consortia/?lang=en

4.1 The National Support Programme and regional consortia

The National Support Programme (NSP) supports schools and teachers implementing the LNF and developing numerical reasoning. The NSP will provide training, guidance and resources to help you at every stage of the process when this aspect of your provision has been identified and agreed as a priority for development. See National Support Programme (NSP) in the Weblinks above for more details of the phased support available to schools.

You will also find that a range of support for numeracy is available through your regional consortium. Developing numerical reasoning will be a priority area for consortia numeracy teams as they work to share good practice, skills and knowledge, magnify local strengths and build capacity. The support provided through the NSP will be carefully coordinated in order to complement the specialist support available from the consortia. See 'Regional consortia' in the Weblinks for more details of the role of the consortia, and 'Personal support' (section 4.4 following) for information about the important role played by Outstanding Teachers of Numeracy.

4.2 Key publications

This handbook aims to provide some of the key information that you can draw on to lead the development of numerical reasoning in your school. There is a great deal of other material available, of which the following is a selection available on the Learning Wales website:

- The **LNF** itself, along with the 'Information' booklet to support schools
- The **Progression Map**, which adds detailed guidance on expectations for developing numerical reasoning across the curriculum and age range

- The Training Pack to support the introduction of the LNF (a series of workshops for primary and secondary schools, with PowerPoint presentations and accompanying notes)
- The booklet Assessment for learning and the National Literacy and Numeracy Framework
- The booklet Curriculum planning guidance
- The background paper on numerical reasoning referenced in the Leadership guide
- The *Leadership guide* for developing numerical reasoning
- The video summaries of key points from the introductory training for school leaders
- The Media Package developed by the National Support Programme (NSP) to support schools with numerical reasoning.

4.3 Other resources

There are many other resources that will help you to develop numerical reasoning in your school.

- Learning Wales (http://learning.wales.gov.uk) should be your first destination, as it includes a range of useful materials that are specifically designed to support numerical reasoning. For example, the 'Reasoning in the Classroom' materials include a variety of adaptable tasks for primary and secondary classes.
- National Numeracy (http://nationalnumeracy.org.uk) and the National Centre for Excellence in the Teaching of Mathematics (www.ncetm.org.uk) both have many resources and ideas that will be useful.
- You will also find freely available a wealth of relevant problem-solving and numerical reasoning ideas in popular mathematics education websites such as Nrich (http://www.nrich.org) and Bowland Maths (http://www.bowlandmaths. org.uk). The Nuffield Foundation has a range of free resources that may be useful, including a suite of activities on applying mathematical processes: (http://www.nuffieldfoundation.org/applying-mathematical-processes).

Remember that the most valuable resources that any school has are time and people. Time for staff to work together, sharing their expertise, ideas and experience is often the single most effective driver of professional development and improved learning that a school can invest in.

Talking about, and reflecting on your own learning will help develop your thinking – just as your learners talking about their own learning will help develop theirs.

4.4 Personal support

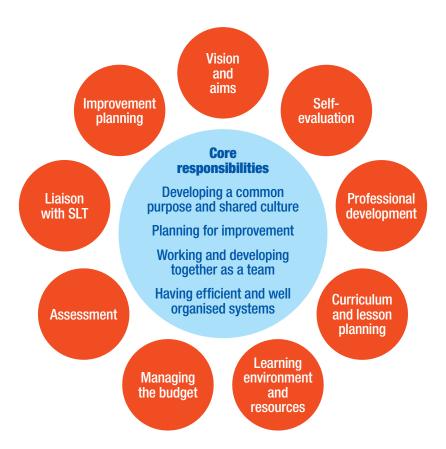
The NSP will continue to provide a range of training events and online resources; these include:

- A Media Package in the form of a DVD, which has been created in consultation with numeracy teams from all four regional consortia. It consists of two modules designed to support all members of the teaching and support staff in schools to understand what numerical reasoning is and how to approach its development in schools. It also provides useful links and further guidance to support the embedding of numerical reasoning in your classroom. This package can be delivered by numeracy leads in schools or by NSP partners.
- Classroom-based workshops the NSP has developed workshops and materials for each school phase. These can be delivered, at schools' request, by specialist NSP partners. These workshops are designed to build the capacity and confidence of teachers in the teaching of numerical reasoning across the curriculum.

Appendix – NCETM audit and development tool

An alternative tool is provided by NCETM. It looks at the different aspects of subject leadership that must be considered in order to develop an effective development plan, through an interactive resource designed to support middle leaders in primary and secondary schools. See: https://www.ncetm.org.uk/resources/21309

Key elements of subject leadership (NCETM, 2014)



This section of the NCETM website, 'Excellence in Mathematics Leadership' will be very useful for numeracy and mathematics leaders in schools introducing developing numerical reasoning. One set of downloads available from Excellence in Mathematics Leadership sets out four 'core responsibilities' for numeracy and mathematics leaders. It shows how you might assess your own school in each core responsibility against a four-level scale and how to progress up the scale.

The resource was created with mathematics in mind, rather than having a specific focus on numerical reasoning. The diagram above lists one of the core

responsibilities, entitled 'Developing a common purpose and shared culture'. The resource sets out a description of characteristics of a school operating at 'category 4' and suggests steps it might take to move to category 3 (as shown below). A similar description and steps for categories 3, 2 and 1 are also provided. Clearly, you would want to adapt the language and labels (for example the term 'category') to suit your own context but a tool like this is highly adaptable; moreover, staff discussions about how to adapt it would be extremely worthwhile development activities in themselves.

4 Description

- There is no agreed philosophy for the teaching of mathematics, and observations demonstrate conflicting approaches, messages and classroom climates that hinder learning.
- The views of other stakeholders are not sought and do not feed into the aims.
- Teachers' enjoyment of mathematics is not evident and they are reluctant to improve classroom practice. There are few opportunities for reflection.
 Teachers rarely discuss mathematics and, when they do, it tends to be either negative or based around classroom management.
- The learning environment is not used to encourage or promote an appetite for learning.
- Most pupils have negative attitudes towards mathematics.

Moving to the next level If you are in category 4:

How can you create a vision statement for mathematics? Which stakeholders is it important to involve? In what way might stakeholders be able to make a contribution? How can you encourage positive talk about mathematics within the school? How can you use the learning environment to promote mathematics? How can you investigate the reasons for pupils' attitudes towards mathematics and their image of themselves as mathematicians?

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References

Mason, J. (2008) 'Making use of children's powers to produce algebraic thinking', in J. Kaput, D. Carraher & M. Blanton (eds.) *Algebra in the Early Grades*. New York: Lawrence Erlbaum, pp 57–94.



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