

A Joint Report by the Education and Training Inspectorate and the Department of Education and Skills Inspectorate on Promoting and Improving Numeracy in Post-Primary Schools

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Glossary of abbreviations and terminology used in commentary extracts and report

AfL	Assessment for Learning
book-scoops	A process in which students' work in homework/classwork/copy books is monitored and appropriate feedback is provided to the teacher
CASS	Curriculum and Advisory Support Service
CAT	Cognitive Ability Tests
CCEA	Council for Curriculum, Assessment and Examinations
CIC	Common Introductory Course - the common mathematics course for 1 st year students in Junior Cycle
DCG	Design and Communication Graphics
DE	Department of Education
DEIS	Delivering Equality of Opportunity in Schools
DES	Department of Education and Skills
ETI	Education and Training Inspectorate
Financial Capability	The development of students' financial capability is an aim of the curriculum in the North and mathematics has responsibility for the development of many of the skills associated with this aim
GCE	General Certificate of Education – see Appendix 2
GCSE	General Certificate of Secondary Education – see Appendix 2
GeoGebra	An open source dynamic mathematics software
Have You Got Maths Eyes?	An initiative in the South designed to promote 'building a positive image of mathematics'
HoD	Head of Department
ICT	Information and communication technology
IEP	Individual Education Plan
INSET	In-service training
KS	Key Stage – see Appendix 2
LoPs	Levels of Progression – attainment levels for assessing Using Mathematics, reported to parents at the end of KS1, KS2 and KS3
Mathématiques sans Frontières	A European mathematics competition
Catch-up Programme	A numeracy intervention programme in the North supported by the Southern Education and Library Board
Mathematics Challenges	A suite of mathematics competitions run by the UK Mathematics Trust
MyMaths, Numeracy Workout, MathsWatch	Commercial mathematics software packages
NFER	Nuffield Foundation Education Research – previous name for GL Assessment, which has devised Progress in Mathematics (PIM), a standardised mathematics assessment

PDST	Professional Development Service for Teachers
PISA	Programme for International Student Assessment
Project Mathematics	A major curricular reform in mathematics for Junior and Senior Cycles; it has been phased in since 2008 and was fully implemented for students entering 1 st year in September 2013
QWC	Quality of Written Communication – assessed in public examinations in the North
SEN	Special Educational Needs
SENCO	Special Educational Needs Co-ordinator
SSE	School Self-Evaluation
STEM	Science, Technology, Engineering and Mathematics
Tarsia	An open source software to help formulate mathematics jigsaw matching activities
TIMSS	Trends in International Mathematics and Science Study
Together Towards Improvement	ETI document to aid school self-evaluation
'true, false, iffy' tasks	Mathematical statements which students decide are always true, always false or sometimes true
TY	Transition Year - see Appendix 2

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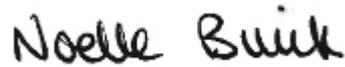
Foreword

This report builds upon important collaborative work involving the Education and Training Inspectorate and the Department of Education And Skills Inspectorate over many years.

Recent work on numeracy has been of major importance to both jurisdictions on the island, arising from the realisation that a good quality of teaching and learning in numeracy is essential for the learner's success in all areas of learning. This report follows on similar work undertaken in primary schools in the recent past, but moves the focus to numeracy and the adolescent learner.

The fact that each author of this report had the opportunity, as part of the North-South Inspector Exchange programme, to work alongside their counterpart in the other jurisdiction strengthens the basis for this work.

We welcome this publication and commend it to all with an interest in education but especially to those whose work relates to the promotion of high standards of numeracy. In doing so, we wish to extend our gratitude to the inspectors, from both Inspectorates, who compiled this report, namely: Nick Todd (ETI) and Séamus Knox (DES Inspectorate).



Harold Hislop, Chief Inspector DES

Noelle Buick, Chief Inspector ETI

1. Introduction

Under the North/South Ministerial Council, the Literacy and Numeracy Working Group commissioned the Education and Training Inspectorate (ETI) and the Department of Education and Skills (DES) Inspectorate to research and report jointly on the key features of successful teaching and learning in literacy and numeracy at primary level.¹ Following the success of this joint venture, the Working Group commissioned two further reports to identify best practice at post-primary level. This report is the second² of these and focuses explicitly on how to promote and improve numeracy across the curriculum.

Whereas in the past, the role of developing the mathematical skills of students was seen as the preserve of the mathematics department, increasingly the importance of our young people being able to use and apply these skills in various contexts has been recognised and highlighted. Both departments, Department of Education (DE) and the DES, have developed and launched new strategies (*Count, Read: Succeed*, DE, 2011; and *Literacy and Numeracy for Learning and Life*, DES, 2011) in which this broader perspective has been emphasised.

In recent years, each Inspectorate has published separately reports on mathematics at post-primary level, but the aim of this report is to extend the focus beyond the mathematics classroom and take a broader perspective on how best to develop the numeracy skills of our young people. To this end, the report will identify good practice in numeracy across the curriculum. Furthermore, to engage the reader – namely, school and subject leaders and teachers in post-primary schools – and to provide exemplars of good practice, the report includes extracts from commentaries written by the ten participating schools.

The findings of the report are informed predominantly by joint visits to four schools – two in the North and two in the South (see Appendix 1). The visits included lesson observations and meetings with relevant personnel, including the subject leaders/heads of department (HoD) of other subjects. The lessons visited included subjects which the schools identified as having significant impact on their students' numeracy development. Each school was also invited to write a commentary on its numeracy provision, how it is managed and the effect it has had. Each commentary also outlined the role of self-evaluation in the cycle of improvement with regard to numeracy.

In addition to the four schools visited, three other schools in each jurisdiction were also invited to write a commentary.

It was clear from the commentaries that much of what the ten schools are doing is similar. The characteristics of effective provision are common to the North and South: they are independent of not only the governance and management arrangements, but also the public examination systems (see Appendix 2). Extracts from, rather than the whole of, each commentary have been used. The repetition and duplication which does occur in the extracts emphasises that there are common features to what constitutes effective provision.

¹ <http://www.eti.gov.uk/index/surveys-evaluations/surveys-evaluations-primary/surveys-evaluations-primary-2010/a-joint-report-by-eti-and-des-on-how-best-to-promote-and-improve-literacy-and-numeracy-in-our-schools-dec-2010.pdf>

² The first report being the companion report focusing on literacy

2. What is numeracy?

The word *numeracy* was first used in 1959 to mirror the meaning of *literacy*. From its first use, it has had various interpretations, but the two strategies, *Literacy and Numeracy for Learning and Life* and *Count, Read: Succeed*, make its meaning clear. Numeracy embraces all aspects of being a mathematical thinker and is much more than being able to calculate with fluency and accuracy. It involves the transferable skills needed to think critically, to communicate effectively and to make a full contribution to society in this increasingly data-rich world.

Numeracy is not limited to the ability to use numbers, to add, subtract, multiply and divide. Numeracy encompasses the ability to use mathematical understanding and skills to solve problems and meet the demands of day-to-day living in complex social settings. To have this ability, a young person needs to be able to think and communicate quantitatively, to make sense of data, to have a spatial awareness, to understand patterns and sequences, and to recognise situations where mathematical reasoning can be applied to solve problems. (*Literacy and Numeracy for Learning and Life*, DES, 2011)

Numeracy is the ability to apply appropriate mathematical skills and knowledge in familiar and unfamiliar contexts and in a range of settings throughout life, including the workplace. It involves the development of an understanding of key mathematical concepts and their interconnectedness, appropriate reasoning and problem-solving skills, the proficient and appropriate use of methods and procedures (formal and informal, mental and written) and active participation in the exploration of mathematical ideas and models. (*Count, Read: Succeed*, DE, 2011)

According to Anita Straker³, '*Numeracy is what you develop when you learn mathematics well*' and so a report such as this must consider what lies at the heart of good mathematics teaching.

3. What is good mathematical pedagogy?

It is evident from recent inspections in both jurisdictions and the joint visits to the four schools that good mathematics pedagogy is underpinned by the belief that all students can, and are expected to, achieve to their potential and where high expectations are modelled by teachers and made explicit by the school culture. This is primarily reflected in the manner in which teachers prepare for their lessons and where lesson planning focuses on the quality of student learning rather than content delivery.

Effective mathematics lessons provide students with a context-rich experience where the lesson content is treated with appropriate rigour, links to the wider mathematics curriculum are explored and where the application of mathematics to the students everyday lives are exploited. In the best lessons, the lesson/learning intention is agreed at the outset and the lesson is facilitated through the use of open-ended, engaging and challenging tasks designed to deepen the students' appreciation and understanding of the subject matter. These lessons also feature a plenary prior to their conclusion to establish the level to which the lesson/learning intention has been achieved.

³ Director, National Numeracy Project, 1997

High-quality teacher questioning, which reinforces the lesson's objectives, causes the students to reflect on their learning and demands that they explain their reasoning, is essential to effective student learning. Students' reflection is promoted through the use of questions that feature reduced levels of scaffolding, contain some level of ambiguity and develop their problem-solving skills. The most effective approaches also demand that students reflect before they answer and ask questions in class and engage in problem-posing as well as problem-solving.

Sacred Heart Secondary School, Tullamore, Co Offaly – developing mathematical reasoning

Developing the students' problem-solving skills was agreed as a key target. Firstly, students would be expected to explain and defend their reasoning as an integral part of lesson delivery. This would encourage students to present a logical basis for their argument and allow them to develop higher order mathematical thinking skills. A notice board which would feature open-ended problems every week or fortnight for Junior and Senior students would also be developed.

Colaiste Pobail Setanta, Phibblestown, Dublin, Co Dublin – promoting a range of lesson strategies

The mathematics department agree that mathematics lessons should include a range of teaching methods, including group work, pair work and team teaching and that AfL should be an integral feature all of the lessons. All students are encouraged to ask quality questions. We believe that this will develop the students' communication skills, enhance their appreciation and understanding of mathematics and create a culture of critical reflection.

The best mathematics lessons also incorporate effective pair and group work where the roles of the participants are clear and where the students engage in focused discussion, develop hypotheses and agree on the approach to be used in solving problems. A number of classroom strategies can be used to support student-centered activities and to differentiate the lesson content.

Similarly, approaches that focus on high levels of student engagement, learning and self-awareness are also promoted.

St Mary's High School, Newry, Co Down – promoting self-awareness

We feel high expectations are key to success in mathematics and believe students need to be supported and challenged to reach their full potential. Additional support is provided by classroom assistants and year 13 maths mentors. Our learning cycle process begins with sharing the learning plan with students, discussing the learning intentions, success criteria, thinking and cross-curricular skills, and ICT in advance of each topic. The cycle ends with an assessment and completion of the reflection plan which allows students to reflect on their learning, record their result and identify areas for improvement. Students share their reflection plans with their parents.

We incorporate a wide range of AfL strategies in lessons; we plan effective use of questions placing a greater emphasis on open ended questions so encouraging students to develop their thinking skills and increase their confidence in communication. Our use of peer and self-assessment helps students support each other to understand difficult mathematical concepts and encourages independent learning.

Loreto Grammar School, Omagh, Co Tyrone – sharing resources and approaches

The rapid development of numeracy practices within the mathematics department has been the result of specific action plans which have complemented the overall school development plan. These have included the development and sharing of active teaching and learning resources – mini whiteboards, Tarsia, thinking maps; increased use of ICT – common calculator, graphical calculator, MyMaths; effective questioning strategies; development of QWC and promotion of library resources as an additional learning tool for post-16 students. Mental mathematics is an embedded practice within all mathematics lessons and is an integral component of each KS3 mathematics assessment. Multiple explanations and alternative approaches are encouraged within lessons and highlighted in units of work, to appeal to a variety of learning styles. Students are also encouraged to discuss their work with tasks requiring communication and discussion built in to our programmes, for example “true, false, iffy” tasks. Regular departmental meetings allow for the dissemination of materials and sharing of good practice and as a team we ourselves have undertaken specific workshops addressing particular areas for development before taking them to the students in the classroom.

Patrician Secondary School, Newbridge, Co Kildare – using team-teaching

Team-teaching has been implemented in the past few years in mathematics lessons and is hoped to continue. The team-teaching approach allows for more effective interaction between teachers and students. As students learn at different rates this approach helps to facilitate students’ individual higher achievement, increase students’ level of understanding and to target students that have learning difficulties.

4. What constitutes an effective cross-curricular approach to numeracy?

Section 2 outlined the definitions of numeracy in the two jurisdictions. With these broad definitions in mind, schools need to approach the development of numeracy in their students not only through the subject of mathematics, but also through other subjects: numeracy, like literacy, is a cross-curricular skill that requires a whole-school approach.

Within this cross-curricular approach, there are subjects where mathematics is at the core of the learning of the subject – in which students **do** mathematics on a regular basis and where the concepts are in essence mathematical. Such subjects include: science, technology⁴, geography, business studies, and to a lesser degree home economics and physical education. The participating schools have identified the importance of these ‘carrier’ subjects, but also recognise that other subjects have opportunities for students to extend and consolidate their mathematical knowledge, understanding and skills.

Dean Maguirc College, Carrickmore, Co Tyrone - promoting collaborative learning

Many subjects present students with relevant contexts in which to use their mathematics. Collaborative planning has proven most effective especially in the area of science. Students collect data during a science lesson with subsequent mathematics lessons concentrating on processing, representing and interpreting the data. Students are encouraged to reflect and evaluate not only how their science and mathematical skills have developed but also how their numeracy skills have contributed to their understanding and success in science.

⁴ Including, for example, engineering, construction studies, design and communication graphics and technology

Portlaoise College, Co Laois – promoting consistency in numeracy across subjects

The art, science, geography, home economics, business, DCG/ technical graphics and woodwork subject departments were given a folder containing the cross-curricular links and the timing of each topic in the school year. This allowed teachers to familiarise themselves with the concepts, skills, methods and procedures of certain mathematical topics with the aim to coincide with the teaching of these topics. This is an attempt to implement a consistent approach across the school to numeracy skills development.

Loreto Grammar School, Omagh, Co Tyrone – identifying the mathematics in other subjects

Numeracy is also a key component across a wide variety of subject areas. The personal development (PD) programme for some year groups includes a financial capability component with inputs from the numeracy co-ordinator and the HoD. In the general learning area of languages, mental mathematics is promoted through the target language in the topics of number, time, dates and financial mathematics is promoted through the topics of shopping, eating out, and holidays. In science, numeracy is a regular feature, in particular in the algebraic components of graph work and use of formulae. Teachers regularly discuss the common material and seek consistency for delivery to the students. Components of data handling are evident across a number of departments including home economics, geography, physical education and ICT and we aim for a consistent approach where possible to the terminology and notation used within these. Components of shape including geometry and measure are also apparent across a number of departments including geography, art, and technology. Number skills are also integrated into subjects such as history and religion. At post-16 subjects including politics, health and social care, business studies and sociology also contribute to the cross-curricular aspect of numeracy.

Evidence gathered during the four joint visits, and during other inspections in the two jurisdictions, indicates that numeracy in other subjects is effective when teachers:

- project a positive attitude to the use of mathematics in his or her subject;
- explore authentic contexts which are integral to the learning of his or her subject;
- use explanations, and teaching approaches, in line with those used by the mathematics department and the other main carrier subjects;
- make explicit the ‘cognitive conflicts’ that arise when the same ideas are interpreted differently in their subject and in mathematics, in order that their students embrace and resolve them; and
- support individual students, at the point of need, with the mathematics required in the learning of his or her subject.

Cognitive conflicts can arise when the underlying concept is the same but the conventions are different. For example, the four-figure grid references in geography and co-ordinates in mathematics give rise to just such a conflict. Both provide a means of defining location, but they are different as one defines a square and the other a point. Conflicts also arise when the scenarios are the same but the concepts are different. For example, when students plot points arising from an experiment designed to explore a direct variation relationship – one variable dependent on the other - but the students describe the line of best fit as displaying ‘positive correlation’. Teachers need to make these differences explicit as cognitive conflicts are both **barriers to learning** and **enablers for learning**: some students will be confused if the differences are not explained, while others will extend their understanding when they recognise the similarities.

Recent publications in both jurisdictions, which identify the characteristics of effective teaching and learning in mathematics, have included the need for the teachers to use contexts which arise in other curricular areas and everyday life (see section 3).

Dean Maguirc College, Carrickmore, Co Tyrone – raising students' awareness of numeracy

KS3 students keep a record in their mathematics books of the application of their mathematical skills in other subjects. The range of skills acquired and developed is regularly discussed during mathematics class and in fact there is an eagerness for teachers and students alike to report back to the mathematics department. Students realise that mathematics lessons are a springboard for the application of what they are learning in other subjects and in the real world.

Fort Hill College, Lisburn, Co Antrim – using extra numeracy lessons

The senior leadership team facilitated an extra lesson, dedicated solely to numeracy, for all year 10 students. To establish the scheme of work for this, we sought advice from our board advisor, we discussed possible ways forward within our department and then we approached other curricular areas within our school. Useful communication pathways were formed; subject teachers from home economics, science, business studies, technology and physical education provided questions/tasks that caused difficulty at KS3 level in their respective subjects.

In one group work activity during this extra lesson, students work through levelled questions which are set in cross-curricular contexts. Another learning activity used is the 'carousel' where students work together to solve a cross-curricular problem before moving onto the next table. As a plenary, a student from each group presents their solution to the class. A further example of our clinic approach is the Science Clinic, where students are given a copy of the GCSE physics equation sheet and asked to identify which formula is required in particular cases.

Loreto Grammar School, Omagh, Co Tyrone – using examples from other subjects in mathematics

Teachers regularly discuss the common material and seek consistency for delivery to the students. For example, when delivering formulae and changing the subject in mathematics, the mathematics teachers deliberately expose the students to the formulae they will encounter in physics as provided by the science department. We aim to introduce many topics through real life contexts and encourage students to share their understanding and knowledge in a cross-curricular context, for example, in the delivery of negative numbers in year 8, students are able to connect their learning to timelines in religion and history, to temperatures in science and to heights above and below sea level in geography.

Opportunities from everyday life can also be very effective as a means of not only showing the relevance of a topic, but also developing opportunities for students to explain and share their reasoning.

Dean Maguirc College, Carrickmore, Co Tyrone – using examples from the real world

Developing real life contexts for our lessons has been most beneficial in engaging, and maintaining the interest of our students, enabling them to realise that the mathematics they learn in the classroom has many practical uses in the real world. One example of this is where students explored the relevance of the mathematics they were learning (angles and bearings) to the world of aviation. Students investigated areas such as the numbering of runways, the importance of weight and balance of aircraft and how these are calculated and the interpretation of the dials, switches and measuring instruments in the aircraft cockpit. Students presented their findings to a commercial airline captain during a workshop in the school. Drawing on an aviation context not only consolidated and enhanced students' mathematical skills but sparked interest from students who would normally struggle.

5. How can numeracy be co-ordinated and promoted?

We have seen in the last section how important the cross-curricular approach is to the development of numeracy. How this is managed and achieved is the focus of this section of the report.

It is evident in all ten schools that a commitment at a high level is central to the success of development in this area. This is realised, for example, through:

- having numeracy as a major strand in the school development plan;
- raising the profile of numeracy amongst all members of the school community;
- focusing on numeracy as part of the school self-evaluation process; and
- having regular meetings at which numeracy is at the core of the school's improvement and raising achievement agendas.

Sacred Heart Secondary School, Tullamore, Co Offaly – initiating a whole-school approach

In May 2012 a member of the Professional Development Service for Teachers (PDST) team visited our school to discuss numeracy and to encourage us to develop our practice in this area in light of the Literacy and Numeracy Strategy 2011. Following on from this visit a group of teachers, mostly comprising of mathematics teachers, met and began to discuss their current numeracy practice and their priorities for improvement. At this meeting it was agreed that a whole staff approach was important, and that numeracy should both be discussed and examined at staff level in order that all staff could reflect on the place and value of numeracy in their own subjects. It was also agreed to establish a numeracy committee, comprising of mathematics teachers and teachers from other subject areas. Finally, we discussed our targets and how these would be met. For example, in order to address the poor social attitude to mathematics, and the tacit acceptance of underachievement in mathematics, it was agreed that all teachers, irrespective of subject area, must actively encourage and promote positive attitudes to mathematics and numeracy.

A presentation on numeracy was given at an upcoming staff meeting and all staff members were provided with a numeracy handout to ensure a common approach to the language around numeracy. Staff were encouraged to display appropriate vocabulary clearly in their classroom and to emphasise relevant keywords during lessons. A mathematics dictionary prepared by the school's Transition Year (TY) students was made available across the school.

Antrim Grammar School, Co Antrim – sharing a commitment to raising standards

We are committed to raising the standards of numeracy of all of our students: we want our students to be confident and capable in the use of numeracy to support their learning in all areas of the curriculum and to acquire the skills necessary to help achieve success in further education, employment and adult life. The development of good numeracy skills is a whole-school policy which must be prepared within the framework of the school's development plan and the revised curriculum strand of using mathematics.

St Mary's High School, Newry, Co Down – promoting numeracy as a part of raising standards

To raise standards in mathematics and support numeracy across the curriculum, we have timetabled a fortnightly Raising Standards meeting which is led by the raising standards leader. The team includes the numeracy and literacy co-ordinators, transition co-ordinator and SENCO who work collaboratively to collate data, disseminate pastoral information, and monitor and evaluate progress at all levels.

In the North, schools are expected to have a numeracy policy and a numeracy co-ordinator in position. How the numeracy co-ordinator manages and leads numeracy will depend on the particular circumstances in each school, but the policy is better embedded and has a positive impact on shaping the quality of provision, when the commitment of the whole-school leadership is strong.

In the South, schools are required to undertake a whole-school approach to the self-evaluation and improvement of teaching and learning, including literacy and numeracy. To ensure a cohesive approach, schools are expected to devise strategies that will facilitate structured collaboration between the school self-evaluation (SSE) co-ordinator/team and the literacy and numeracy link teachers. For example, when the school is evaluating its progress in numeracy and devising a school improvement plan, the numeracy link teacher can be part of the SSE team, or indeed can lead the SSE process itself. This helps to develop a whole-school understanding of, and approach to, numeracy while ensuring a co-ordinated approach to improving the numeracy outcomes of students.

Dean Maguirc College, Carrickmore, Co Tyrone – building on policy and audit in the North 1

A numeracy committee was set up with representatives from all areas of study. A numeracy policy was drawn up and shared with all staff; this is regularly reviewed and modified where necessary. Whole staff training was given by the mathematics department to ensure consistency in the teaching, presentation and language used in handling data, in particular, in the drawing and interpretation of graphs. INSET was also provided by the mathematics department aimed at ensuring all teachers encourage students to use a mental/written approach when doing calculations rather than allowing them to reach for the calculator. Advice sheets have been distributed to all staff on handling data to ensure consistency in its teaching, and on mental mathematics suggesting mental mathematics approaches and encouraging estimation, calculation and checking. These are on display in all classrooms.

Many schools undertake an audit of the numeracy provision in all subjects as the first part of a numeracy action plan, and this audit often results in a re-alignment of when topics are introduced by not only the mathematics department, but also through the main carrier subjects. Best practice occurs when the auditing process is sufficiently detailed so as to generate professional dialogue focused on what is taught, how it is taught and on how students learn most effectively.

Dean Maguirc College, Carrickmore, Co Tyrone – building on policy and audit in the North 2

A numeracy audit has been completed by all departments/areas of study indicating topics of a mathematical nature used/taught, and which year group and term identified, and KS3 samples of work have been supplied. The results of this audit have been analysed in the attainment targets of number, algebra, shape, space and measures, and handling data. As a result of this analysis, mathematics frameworks have been adapted to take account of the needs of other departments, e.g. science, geography, home economics. Frameworks have been drawn up for all departments similar to those used by the mathematics department and are reviewed and modified where necessary; these frameworks are displayed alongside teachers' own subject frameworks. In so far as possible, topics are taught in mathematics class before they are met in other subjects. Where this is not possible, members of the mathematics department can meet with teachers in advance of them teaching a topic of a mathematical nature.

Antrim Grammar School, Co Antrim – building on policy and audit in the North 3

The numeracy working group plays an integral role in identifying and prioritising whole-school initiatives relating to numeracy. A recent focus for the group centred on addressing gaps in mathematical knowledge and skills of students in key subject areas at both KS4 and KS5. To address the issue, the numeracy co-ordinator conducted a whole staff numeracy confidence audit along with individual interviews with subject leaders in key areas such as science, geography, business studies, etc. These individual meetings focussed on how these departments addressed numeracy with respect to the standardisation of teaching approaches including: the use of recognised mathematical terminology; support for SEN students; strategies for stretch and challenge; use of homework to consolidate numeracy skills and other strategies that departments use to promote numeracy. Additionally, key carrier subjects which needed additional teaching resources to deliver their own subject specific mathematical content, worked with the numeracy co-ordinator to devise a bank of electronic resources which can now be used to assist teaching specific skills and knowledge within individual subject areas.

Equally in the South, the focus of teacher collaboration to produce more consistent and coherent learning experiences for the students is prioritised.

Kylemore College, Dublin, Co Dublin – building on cross-curricular links in the South 1

A common approach to numeracy within schemes of work has been employed. Teachers are fully aware that they need to understand the mathematics required in their subject in the discourse of their own subject. Teachers in all subject departments now accept that they have a responsibility to promote and encourage a better understanding of numeracy and provide students with the opportunity to apply their mathematical skills within their subject area. We have established cross-curricular links and support the delivery of key mathematical skills and concepts by other subject departments in line with the mathematics department schemes of work.

Portlaoise College, Co Laois – building on cross-curricular links in the South 2

The mathematics department surveyed the numeracy demands of the subjects offered in the school to identify cross-curricular links. This activity allowed the department to adjust the content plan to be followed by students by scheduling the teaching of particular topics in mathematics to coincide with the same topic being covered in other subjects. This provides students with the opportunity to generalise their learning and to transfer their mathematical skills to other contexts.

Patrician Secondary School, Newbridge, Co Kildare – building on cross-curricular links in the South 3

Numeracy is cross-curricular and a consistent approach by all subject departments is encouraged and supported. This is an organic process that requires all departments to constantly liaise with the mathematics department. Cross-curricular strategies that we, as a school, have agreed upon include: a common mathematical language being used across the school; encouraging students to ask themselves ‘can I do this in my head?’; teachers judging if students should carry out calculations themselves or if a calculator should be used; requiring students to defend orally the process they used to solve a mathematical problem; generating mathematics projects that use real life contexts; having a school homework club that is run by TY students who have been advised to encourage students to think for themselves and develop their problem solving skills; and, encouraging logical reasoning, use of data/data analysis and plotting of graphs as part of classwork.

6. How do schools know what they are doing is effective?

School self-evaluation is a collaborative, inclusive and reflective process of internal school review. As part of the self-evaluation process all of the school’s stakeholders reflect on the school’s aims and consider criteria for success within the school’s context and ethos. It is an evidence-based approach which involves gathering information from a range of sources and making judgements with a view to bringing about improvements.

St Mary’s High School, Newry, Co Down – self-evaluating within mathematics

As a mathematics department we work collaboratively to ensure the whole-school cycle of improvement and cycle of evaluation impacts positively on learning and teaching thus improving the learning experience and outcomes for the students. We complete a rigorous self-evaluation process based on together towards improvement indicators, involving the appraisal of both the strategic and operational departmental action plans. All members of the department reflect on their teaching and student learning throughout the year and this is evidenced in the end of year evaluations. The HoD presents and discusses the evaluations and recommendations with the principal. At the beginning of the academic year, we identify our key priorities for development, based on the school development plan, the KS3 and GCSE results and the outcomes of the evaluation process.

Because numeracy is ubiquitous, it has an impact on student progress in all subjects. This means that numeracy development requires a whole-school approach that gives students every possible opportunity to acquire, apply and consolidate their numeracy skills. When schools are considering numeracy development across the school, they first reflect on how the students are performing in this area and set evidence-based targets for improvement.

Kylemore College, Dublin, Co Dublin – using performance data to monitor and evaluate

As part of our work under DEIS, one of the targets, set in the second DEIS Plan (2012-2015), was to design, administer and analyse a numeracy competency test. This test was designed to measure numeracy competency based on both the five strands of the primary mathematics curriculum as well as the Common Introductory Course (CIC) of the Project Mathematics curriculum. Statistics on the outcomes of the competency test have been retained and analysed since 2011. The improvement in attainment in this test is monitored to ensure the specific targets within the DEIS plan are being met.

Dean Maguirc College, Carrickmore, Co Tyrone – using book-scoops to monitor and evaluate student learning

Book-scoops are used to monitor the consistent and accurate application of students' numeracy skills across the curriculum, to ensure that guidelines given to staff in relation to handling data and methods of calculation are being followed and to inform future developments. Written feedback is given to staff regarding the range and quality of numeracy work seen: is there evidence of adherence to the numeracy framework and appropriate integration of numeracy into topics taught?; is there evidence of a range of graphical skills and adherence to training and advice sheets given?; and, is there evidence of mental, written and calculator methods where appropriate? Monitoring the effectiveness of cross-curricular numeracy in our school through book-scoops helps raise standards of achievement.

Schools gather evidence about outcomes for students, teacher practice and student learning experiences in many different ways. During this process they consider the evidence they already have and identify any additional evidence that might prove useful and the tools required to gather it. Once gathered, the evidence is analysed and areas that are working well and those requiring attention are identified.

Portlaoise College, Co Laois - monitoring and evaluation leading to further action

It was agreed that the PDST's numeracy diagnostic test would be administered to the existing 1st year group. The analysis of the results would identify areas for improvement and a strategy for such improvement, including retesting the student cohort, would be developed.

7. What other factors matter?

Improving student disposition

For some, if not many, students it appears to be acceptable to declare their lack of interest and their unease with studying mathematics. For some, it has become a badge of honour to state, 'I can't do maths' or 'I'm no good at maths'. These attitudes, which on occasion reflect what their parents say, are closely connected to a lack of resilience when they meet problems that go beyond routine procedures or material they have recently covered. This needs to be actively addressed and the schools visited used a variety of strategies ranging from celebrating the success of students in public examinations and mathematics competitions to inviting past students in to talk about the mathematical aspects of their careers.

Colaiste Pobail Setanta, Phibblestown, Dublin, Co Dublin – developing an interest in mathematics 1

All mathematics teachers have mathematical keywords displayed in their rooms in an effort to improve literacy. There is an illustrated mathematics dictionary available in mathematics rooms for student use. Mathematics posters and teasers are displayed throughout the school with some of the posters outlining all the careers for which mathematics is required. Maths Week is celebrated each year and includes: mathematics table quizzes, Drop Everything and Sudoku, mathematics puzzle of the week, 1st year mathematics treasure hunt, Have You Got Maths Eyes? poster competition, etc.

Loreto Grammar School, Omagh, Co Tyrone – developing an interest in mathematics 2

Careers & STEM related activities are also integral to our numeracy programme. Year 8 students are introduced to STEM from the outset. Past student STEM profiles are displayed across many subject areas. This year, we invited back a number of past students now working in STEM-related careers to enhance our post-16 choices night. Email contact for post-16 students with students in a variety of university courses is also facilitated. Cross-curricular STEM activity events, with a numeracy dimension have been availed of. The focus was also to instil greater interest among students in mathematics/numeracy activities. Initial developments used to achieve this included; a numeracy notice-board which exhibited fascinating number facts, relevant websites, news articles, careers; greater participation in events such as Fantasy League Football, Mathematics Challenges (Leeds University), Mathématiques sans Frontières, World Maths Day; and inclusion of a numeracy page in the school magazine. Recognition of achievements in numeracy events are acknowledged at school assemblies and also at our end of year prize-giving ceremony.

Portlaoise College, Co Laois – developing an interest in mathematics 3

In order to change students' perceptions and attitudes to mathematics, we introduced a number of initiatives which included Maths Bingo and School Lotto.

Maths Bingo is run by the TY class every Monday at lunch time. A series of mathematical problems and equations are used to develop basic mathematical skills among the 1st year students. It provides a relaxed, fun approach to mathematics which helps to promote enjoyment of mathematics. The TY class developed their understanding of probability through setting up and administering the school Lotto. Instead of simply picking a number between 1 and 30, each student must show a calculation used to achieve it. In order to claim any winnings the calculation must be correct and in order to challenge higher level students, they were expected to include a specified number of steps in their calculations.

In addition to the range of strategies above, schools promote initiatives to involve parents in helping their children learn and understand mathematics. This helps to ensure that learning doesn't end at the classroom door.

St Mary's High School, Newry, Co Down – involving parents 1

We value parental involvement in promoting a positive 'can do' perception of mathematics and numeracy across the curriculum. All year 8 parents are presented with a support Maths Guide in the first term and parents have participated in evening classes to raise awareness of mathematical strategies at KS3.

Portlaoise College, Co Laois – involving parents 2

Mam-Dad Help-Sheets are sent home to the parents of 1st year students at the start of every chapter. The sheets outline keywords and concepts and show worked examples for topics within the chapter. The help-sheets encourage parental involvement in their child's mathematics education. They can also be used to assist in homework problems or as a study aid before exams.

Addressing difficulties at transition

In both jurisdictions, the changes that arise at the transition from primary to post-primary school have been identified as major contributors to students regressing in post-primary mathematics. The international comparison studies, TIMSS and PISA, indicate that this regression is perhaps more evident in the North. In 2010, ETI completed a survey looking at this transition, and it has been highlighted in the most recent Chief Inspector's Report. The schools in the survey have made progress in addressing this important issue.

Research conducted on behalf of the Economic and Social Research Institute (ESRI) in 2007 shows that entry to lower secondary schools in the South leads to gradual decline in academic motivation, self-perception, and school-related behaviours over the early adolescent years with, for example, the percentage of students describing schoolwork as interesting falling to just above 50% by the end of 2nd year and a similar number having negative attitudes to homework by the time they reach 3rd year. Easing the negative impact of transition from primary to post-primary is essential in facilitating higher achievement and preventing students from developing negative attitudes to school. In attempting to address these issues the mathematics syllabuses/specifications at second level were changed to more closely connect to the mathematics syllabus in the Primary School Curriculum.

Dean Maguirc College, Carrickmore, Co Tyrone – sharing primary and post-primary schemes of work

Links have been established between our school and the local feeder primary school re: (1) development of strategies to promote continuity and progression across KS2 and KS3; and (2) sharing of information and expertise about the numeracy curriculum. KS3 teachers have a clearer understanding of students' abilities on entry to secondary school and are able to build on students' prior attainment more effectively. Sharing of schemes of work avoids repetition of work for students in year 8, and year 7 and year 8 frameworks are displayed alongside each other in our classrooms. Year 7 students have on several occasions participated in investigative work assisted by year 8 (former students) and year 14 students. We aim to further develop partnerships with feeder primary schools that will improve continuity of learning: post-primary teachers will be more familiar with teaching and learning styles that occur at primary level and vice-versa.

St Mary's High School, Newry, Co Down – surveying students' views on transition

We have developed positive working relationships with our feeder primary schools and have held meetings to discuss the delivery of mathematics lessons in KS2 and KS3. Each year, students in years 8 and 11 complete a questionnaire that gives insight to the learning experiences at transitional stages and informs our future planning. Each year a number of our year 13 students participate in the Maths Mentoring Programme in our main feeder primary schools. The students attend their link primary schools weekly to support individual students or groups either with the year 2 Catch-up Programme or numeracy support. We receive very positive feedback about the children's enjoyment and growing confidence in mathematics and their progress is measured through testing.

Antrim Grammar School, Co Antrim – building on prior learning in first year

In order to ensure continuity and progression in mathematical and numerical skills, the mathematics department also undertook a review of KS2 programmes of study in conjunction with primary school colleagues. This helped ensure the year 8 syllabus consolidated existing knowledge and built in opportunities to extend learning further. Feedback from parental surveys at year 8 has helped to confirm that students are showing a progression in both mathematical knowledge and skills as well as, most importantly, confidence.

In addition to direct links with feeder schools, all the schools are aware of the difficulties that can arise in the first year at post-primary school and have, or are planning to have, initiatives in place to address this.

In the best cases, very good links are maintained with the feeder primary schools and the students' educational and other needs are well-established prior to entry to the school. The mathematical abilities of incoming students are determined using an appropriate testing process and apart from measuring student performance, the analysis of the outcomes of the assessment identify areas of the curriculum where students require additional input throughout first year and also areas where performance is particularly strong. The outcomes of the analysis are reflected in the content, schedule and assessment of the first year mathematics programme and the cross-curricular numeracy support they receive.

Colaiste Pobail Setanta, Phibblestown, Dublin, Co Dublin – involving students in improving numeracy across subjects in first year

The literacy and numeracy team are currently working on the idea of creating a language, literacy and numeracy booklet for all incoming 1st year students – it will act as a reference point for keywords and techniques. We will give all teachers a copy too. It should help to harmonise common approaches in subjects e.g. dealing with fractions, decimals, percentages, measurements, etc, so that we are all teaching the one method to avoid confusion for students. TY students are currently working on this.

Addressing the needs of students

All the schools in the survey place a high priority in addressing the needs of those students who are falling behind when compared with their peers. The use of standardised tests and internal assessments play a central role in distinguishing whether low achievement is actually underachievement, that is, students falling below their potential as indicated by the full available evidence, including teachers' professional judgement. Best practice occurs where the use of tracking data is augmented by professional judgement not only from mathematics teachers, but also from all teachers, especially those of the main carrier subjects.

The nature of the support can vary but in best practice it is well-planned, perhaps through an Individual Education Plan (IEP) that has a numeracy element, if not a sole numeracy focus.

Loreto Grammar School, Omagh, Co Tyrone - providing one-to-one support

Numeracy support is availed of in a number of formats. In KS3 students are taught in mixed-ability classes. Students who are most in need of additional support, as identified by benchmarking and tracking data, avail of a weekly one-to-one slot with the numeracy support teacher. Such students can be identified by any department where a weakness in numeracy becomes apparent. For example, students with a weakness in graph work in science have availed of additional support. Personalised, non-generic IEPs are drawn up for these students in consultation with student, parent, subject teacher, mathematics teacher, numeracy co-ordinator and SENCO to facilitate their specific needs. Peer mentoring by year 13 AS Level mathematics students is also available for other KS3 students struggling with isolated topics.

Patrician Secondary School, Newbridge, Co Kildare – using performance information to screen, diagnose and measure

In relation to the National Literacy and Numeracy Strategy and DES Circular 0025/2012, we set out to create and maintain a strong focus on literacy and numeracy within a broad and balanced curriculum that caters for the needs of each individual student.

Our feeder primary schools send a copy of the end of year report card, including information from standardised tests in literacy and numeracy, of each student to us. We then use this data to assist our self-evaluation of teaching and learning, specifically in relation to literacy and numeracy, and in drafting our school improvement plans. This data acts as a benchmark against which student progression in literacy and numeracy is measured. In addition, in May prior to their transfer, all incoming 1st year students are tested using the CATs. This determines their aptitude in the areas of numerical, verbal and non-verbal (spatial awareness) skills. These tests highlight underachieving students in each of the above areas. This is essential for the resource department to develop and implement IEPs to cater for these students' needs.

Dean Maguirc College, Carrickmore, Co Tyrone – using performance information to track progress, set targets and identify strategies

Results of formative assessment and standardised tests (CATs, NFER, etc) are used to track progress of individuals, classes, year groups and a spreadsheet relating to students' numeracy attainment is drawn up by the HOD and circulated to all staff, informing numeracy planning across all departments. Available data is used to set appropriate targets, to raise standards and to identify numeracy targets and strategies on IEPs. There is a weekly meeting of the numeracy co-ordinator, SENCO and the principal.

Many schools use student peers to provide additional support. It was clear during the visits that the students providing the support gain much from the experience, not only in their confidence, but also in their own numeracy. In instances of best practice, classroom assistants (or learning support assistants) are trained to provide specific numeracy support.

St Mary's High School, Newry, Co Down – using students and assistants to provide support

The mathematics department use quantitative and qualitative data to further identify students who are underachieving in mathematics and employ a range of intervention strategies to support students. Year 14 students are trained as learning partners and maths mentors to support students in years 8 and 9. They work with individual students or small groups in mathematics lessons and students have reported that their confidence, enjoyment and understanding of mathematics have increased. We value the important role classroom assistants play in supporting students and developing their confidence in learning mathematics. To date, all classroom assistants have been trained and up-skilled by the CASS advisors and numeracy co-ordinator to support the students' understanding of mathematical concepts. All our classroom assistants participate in whole-school INSET on AfL strategies and the focus this year has been the use of effective questioning and peer and self assessment.

Enhancing students' number fluency and accuracy

While accepting that numeracy is much more than fluency in recall of number facts and accuracy in computation, the schools in the survey appropriately have identified these two life skills as areas for development.

Colaiste Pobail Setanta, Phibblestown, Dublin, Co Dublin – promoting mental mathematics

We conducted a student attitudinal survey to assess their attitudes to mathematics and numeracy and asked them to identify areas where they were encountering difficulties. Percentages were identified as a problem area for students, and in 2013-2014, our numeracy goal focused on improving our student's mental arithmetic.

One initiative entails all teachers returning all their test results in fraction format and asking the students to calculate the percentage they have received themselves. This is a whole-school approach: every teacher uses the same method to convert fractions to percentages. Also, at the beginning of every mathematics lesson students complete eight short mental arithmetic calculations (2 additions, 2 subtractions, 2 multiplications and 2 divisions) and all subject teachers were asked to encourage students to complete basic calculations without the use of a calculator when the opportunity arose during lessons.

It is often the case that students are allowed to use their calculators too readily in subjects other than mathematics thus eschewing opportunities to maintain and consolidate the students' mental and written calculation skills. The evidence from primary school inspections in the North shows that mental mathematics skills are being promoted through planned and incidental opportunities, but evidence indicates that the promotion of these skills reduces in post-primary schools.

Loreto Grammar School, Omagh, Co Tyrone – promoting the effective use of the calculator

Following a staff audit in 2005, developments in a whole-school context were: firstly, the introduction of a common calculator with an associated student document supporting its use in all required subject areas; and secondly, exploiting the learning potential for mental mathematics across the curriculum.

The role of estimation both prior and post calculation has been widely accepted as a very important skill which can enhance performance in further education and the world of work. For example, employers often refer to new employees not having a 'feel for number' when they fail to spot that an answer is out by an order of magnitude. In many schools, the skill of estimating is taught in mathematics class but opportunities to put it into practice are missed in not only other subjects, but also in mathematics itself.

In the South, an initiative promoted in schools targeting numeracy as part of their SSE process is the use of *Estimate, Calculate, Check* where students are expected to estimate the outcome of calculations they routinely encounter in lessons, they then carry out the calculation and finally, using a calculator, they check their answers. This gives students a greater appreciation of the properties of number and the effect of common operations on number size.

Enriching mathematical learning with ICT

While in the past the electronic calculator was the only readily available technology, increasingly teachers and students can avail of a range of generic and specific software on a range of hardware technologies. It is generally accepted that many benefits arise from the appropriate use of such technology, and the schools in the survey are fully aware of these benefits.

St Mary's High School, Newry, Co Down – using ICT

ICT is used extensively in our department and across the curriculum. Students are motivated and engaged in their learning when using the interactive whiteboards. Mathematical tools and resources are easily accessed and used by students and teachers in an interactive way to support learning. Students respond positively to the wide range of mathematical software including iPad apps, Maths Watch and Numeracy Workout which are available in school and at home to reinforce concepts taught in class and encourage independent learning.

However, the use of specialised mathematics software, such as GeoGebra, which allows students to explore and problem-solve within an integrated mathematical landscape is still at a very early stage. The use of dynamic software changes the way in which students encounter and understand mathematics as it provides teachers with the opportunity to present them with open-ended and multi-layered tasks that demand that the students develop hypotheses, test their reasoning and draw conclusions. Such software can also make the more difficult concepts more accessible to students by allowing them to manipulate the conditions attached to functions or other relationships and observing the effects.

It is also worth noting that the use of ICT will not always enhance mathematical learning and can, on occasion, do more harm than good. This is particularly true when the ICT serves narrow objectives not focused on deepening the students' mathematical knowledge, understanding and skills.

8. The way forward

The DE and DES have recently developed and launched major strategies to improve literacy and numeracy. Both strategies take a broad perspective on what constitutes numeracy and place a high importance on exploring, modelling, reasoning, explaining, problem-solving and thinking mathematically.

If our students are to attain the numeracy skills that will empower them to think critically, to communicate effectively and to make a full contribution to this increasingly data-rich society, then schools need to ensure that:

- their students experience high quality mathematical pedagogy, as summarized in section 3, in lessons;
- the teachers of other subjects follow and promote the principles of effective numeracy provision outlined in section 4;
- the teachers, subject leaders and school leaders develop and promote a co-ordinated and coherent cross-curricular approach to their students' mathematical learning experiences, as illustrated in section 5;
- the subject and senior leaders self-evaluate the numeracy provision, as discussed in section 6, in order to effect and sustain improvement; and
- the additional factors included in section 7 are considered and acted on, particularly the need to improve their students' dispositions towards mathematics.

Underscoring all of this is the belief that *'Maths is fun – hard fun: it's not a trivial pursuit'*⁵. Schools need to have a collective belief that students are engaged, rather than put off, by challenging mathematical activities – this belief being the basis for high expectations of what their students can attempt and ultimately achieve.

⁵ by Seymour Papert, relayed by Celia Hoyles at ICME11 in 2008.

Participating schools

The following schools were visited and provided a commentary:

Antrim Grammar School, Co Antrim, is a co-educational, 11-18 school with approximately 750 students.

St Mary's High School, Newry, Co Down, is an all-girls, 11-18 school with approximately 550 students.

Portlaoise College, Co Laois, is a co-educational, 11-18 school with approximately 350 students

Colaiste Pobail Setanta, Phibblestown, Dublin, Co Dublin, is a co-educational, 11-18 school with approximately 800 students.

The following schools provided a commentary:

Dean Maguirc College, Carrickmore, Co Tyrone, is a co-educational, 11-18 school with approximately 490 students.

Fort Hill College, Lisburn, Co Down, is a, co-educational, 11-18 school with approximately 900 students.

Loreto Grammar School, Omagh, Co Tyrone is an all-girls, 11-18 school with approximately 900 students.

Kylemore College, Dublin, Co Dublin, is a co-educational, 11-18 school with approximately 320 students.

Patrician Secondary School, Newbridge, Co Kildare, is an all-boys, 11-18 school with approximately 700 students.

Sacred Heart Secondary School, Tullamore, Co Offaly, is an all-girls, 11-18 school with approximately 350 students.

School systems

Typical Age range	South of Ireland	North of Ireland
10-11	Primary – Fifth Class	Primary – year 7 Using Mathematics (LoPs 1 to 5)
11-12	Primary – Sixth Class	year 8 – Key Stage 3
12-13	Junior Cycle 1 st year	year 9 – Key Stage 3
13-14	Junior Cycle 2 nd year	year 10 – Key Stage 3 Using Mathematics (LoPs 1 to 7)
14-15	Junior Cycle 3 rd year Junior Certificate at Foundation, Ordinary or Higher levels. Foundation Level only occurs for Gaelge and Mathematics	year 11 – Key Stage 4
15-16	Transition Year (Not compulsory)	year 12 – Key Stage 4 GCSE at Foundation or Higher tiers
16-17	Senior Cycle 5 th year	year 13 – Sixth Form GCE (AS Level)
17-18	Senior Cycle 6 th year Leaving Certificate at Foundation, Ordinary or Higher levels. Foundation level only occurs in Gaelge and Mathematics	year 14 – Sixth Form GCE (A Level)

Relevant publications

Literacy and Numeracy for Learning and Life, DES 2011

http://www.education.ie/en/Publications/Policy-Reports/lit_num_strategy_full.pdf

Chief Inspector's Report 2010-2012, DES 2012

<https://www.education.ie/en/Publications/Inspection-Reports-Publications/Evaluation-Reports-Guidelines/Chief-Inspector%E2%80%99s-Report-2010-2012-Main-Report.pdf>

Research into the impact of Project Mathematics on student achievement, learning and motivation, NFER 2013

<http://www.ncca.ie/en/Conference/Impact-of-Project-Maths-Final.pdf>

Effective Literacy and Numeracy Practices in DEIS Schools, DES 2009

http://www.education.ie/en/Publications/Inspection-Reports-Publications/Evaluation-Reports-Guidelines/insp_deis_effective_literacy_and_numeracy_09_pdf.pdf

Moving Up. The Experiences of First-Year Students in Post-Primary Education, Liffey Press, 2004

Pathways through the Junior Cycle: the Experience of Second Year Students, Liffey Press, 2006

Gearing Up for the Exam: The Experience of Junior Certificate Students, Liffey Press, 2007

A Joint Report by the Education and Training Inspectorate and the Department and Skills Inspectorate on How Best to Promote and Improve Literacy and Numeracy in our Schools, ETI & DES, 2010

<http://www.etini.gov.uk/index/surveys-evaluations/surveys-evaluations-primary/surveys-evaluations-primary-2010/a-joint-report-by-eti-and-des-on-how-best-to-promote-and-improve-literacy-and-numeracy-in-our-schools-dec-2010.pdf>

Count, Read: Succeed, DE, 2011

http://www.deni.gov.uk/count_read_succeed_a_strategy_to_improve_outcomes_in_literacy_and_numeracy.pdf

Every School a Good School, DE, 2009

http://www.deni.gov.uk/esags_policy_for_school_improvement_-_final_version_05-05-2009.pdf

Together Towards Improvement (Post-primary), ETI, 2009

<http://www.etini.gov.uk/index/together-towards-improvement/together-towards-improvement-post-primary.pdf>

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<http://www.etini.gov.uk/index/support-material/support-material-general-documents-non-phase-related/the-chief-inspectors-report/ci-report-2012.pdf>

Better Mathematics, ETI, 2006

<http://www.etini.gov.uk/index/surveys-evaluations/surveys-evaluations-post-primary/surveys-evaluations-post-primary-2007/better-mathematics-evaluation-and-prompts-for-self-evaluation-and-improvement-in-post-primary-schools.pdf>

Commentary on Post-primary Mathematics Teaching, ETI, 2007

<http://www.etini.gov.uk/index/surveys-evaluations/surveys-evaluations-post-primary/surveys-evaluations-post-primary-2007/commentary-on-post-primary-mathematics-teaching.pdf>

Transition in Mathematics: primary to post-primary, ETI, 2010

<http://www.etini.gov.uk/index/surveys-evaluations/surveys-evaluations-post-primary/surveys-evaluations-post-primary-2010/transition-in-mathematics-primary-to-post-primary.pdf>

Follow-up to Better Mathematics, ETI, 2010

<http://www.etini.gov.uk/index/surveys-evaluations/surveys-evaluations-post-primary/surveys-evaluations-post-primary-2010/follow-up-to-better-mathematics.pdf>

Survey of Best Practice in English and mathematics in Post-primary Schools, ETI, 2013

<http://www.etini.gov.uk/index/surveys-evaluations/surveys-evaluations-post-primary/surveys-evaluations-post-primary-2013/best-practice-in-english-and-mathematics-in-post-primary-schools.pdf>