

TRANSFORMING SCOTLAND
INTO A MATHS POSITIVE NATION

THE FINAL REPORT OF
THE MAKING MATHS COUNT GROUP

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CONTENTS

Chair's introduction	02-05
Transforming public attitudes to maths	06-11
Improving confidence and fluency in maths for children, young people, parents and all those who deliver maths education	12-25
Maths as an essential skill for employment	26-29
Conclusion	30
Group's Remit	31
Summary of organisations and groups providing evidence	32

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CHAIR'S INTRODUCTION

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Scotland has a maths problem. Too many of us are happy to label ourselves as “no good with numbers.” This attitude is deep-rooted and is holding our country back educationally and economically.

The Making Maths Count Group has been set up to consider how to encourage greater enthusiasm for maths amongst children and young people, their parents and carers and the wider public. I am delighted to chair the Group as I believe that everyone can enjoy and achieve in maths.

We have undertaken an extensive programme of engagement work to understand the factors creating negative attitudes to maths and how these can be addressed. Over 3,000 adults and young people responded to our online questionnaire providing their views and ideas about maths. We have held focus groups with children and young people, teachers, parents and carers, college and university students and employers. They have told us what they like and dislike about maths and what we need to do to promote the benefits of maths as a vital life skill.

We identified two main challenges. The first is to convince everyone, whatever their circumstances in life, that they have the ability to become proficient at maths. The second is to convince them of the benefits of doing so.

The strongest messages we received to address these challenges were to make maths more relevant to real life and work and more enjoyable. Making maths more inspiring will help to create greater enthusiasm, encourage greater participation and raise attainment.

We considered evidence on initiatives to promote maths elsewhere in the world from Ireland to South Asia to America and the best practice taking place here in Scotland.

This has led us to focus on three key areas:

- Transforming public attitudes to maths.
- Improving confidence and fluency in maths for children, young people, parents and all those who deliver maths education to raise attainment and achievement across learning.
- Promoting the value of maths as an essential skill for every career.

Creating a positive climate for maths in Scotland requires everyone to contribute. Our work has reinforced our belief in the unparalleled benefits of maths. This ranges from the school pupil who told us that she loved maths and wanted to make her parents proud of her achievements to the CEO of a major Scottish company who pointed out the rich variety of careers that maths opens up, from creating the next generation of mobile phones to enlarging our knowledge of the outer reaches of the universe.

We have made 10 recommendations to transform Scotland into a maths-positive nation. These are:

Transforming public attitudes to maths

1. The Scottish Government should work with partners to commission a sustainable culture change strategy for Making Maths Count. The strategy should:
 - create greater enthusiasm for maths as a vital life skill amongst children and young people, parents and carers and the wider public; and
 - promote the value of maths as an essential skill for every career and an economic imperative if Scotland is to compete internationally.

The strategy should be appropriately funded and have a strong focus on communications and improving public access to a range of maths information and resources including those for family learning.

2. The Scottish Government should work with partners to develop jointly and fund a Maths Week Scotland which brings together events across the country with online and hands-on experiences for young people, their parents and carers and the wider public.
3. Each local authority should develop and implement a strategy to ensure that all schools and nurseries engage with parents, employers and others in their local communities to help children and young people develop greater awareness of the importance of maths to everyday life and future jobs. Education Scotland and local authorities should collaborate to share and disseminate good practice.

Improving confidence and fluency in maths

4. All schools and nurseries should use a wide range of effective learning and teaching approaches to promote positive attitudes and develop high expectations, confidence and resilience in maths.
5. Education Scotland should evaluate the quality of children's and young people's learning experiences and attainment in maths and share examples of good practice.
6. The GTCS, in partnership with Initial Teacher Education Institutions, Education Scotland and local authorities should undertake research on how well ITE students are being prepared to teach maths as newly qualified teachers. The research should include a review of:
 - Minimum entry requirements to ITE for Maths.
 - Other means of ensuring applicants have good quality maths skills, e.g. online testing of applicants' numeracy skills.
 - The extent to which there is sufficient coverage of maths in primary ITE programmes to allow meaningful, quality maths learning in primary schools.
 - The means by which ITE institutions continuously update and improve their programmes and provide a practical focus on teaching and learning styles that instils teacher confidence in delivering maths.
 - The extent to which the probationary year promotes good-quality teaching and learning styles and improving confidence in maths.

7. All sectors of education should promote access to high-quality career long professional learning (CLPL) to increase staff confidence and enhance professional practices in teaching maths to children, young people and adult learners. Each local authority should design, implement and evaluate the impact of a CLPL strategy for teachers and community learning staff to develop their professional practices in teaching maths.
8. Schools supported by the Attainment Scotland fund as part of the Scottish Attainment Challenge should increase their focus on raising attainment in numeracy and include parental engagement in maths as part of their plans.

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Promoting the value of maths as an essential skill for every career

9. To help raise Scotland's skills base and promote our economic competitiveness, Skills Development Scotland, Education Scotland, Scottish Funding Council and other relevant partners should work with employers, colleges and schools to develop an action plan for improving maths skills for employment. This should include a focus on adult learners both as workers and parents. One approach could be to commission an online tool and associated in-work support to help adults test and improve their maths skills. As well as those in work, the action plan should also consider support for those seeking work.
10. The network of Developing the Young Workforce Regional Groups should be asked to contribute to the development and implementation of the action plan in relation to school/employer engagement to promote maths as an essential skill for employment. This should cover primary as well as secondary schools.

We believe that these recommendations are practical, cost-effective and achievable. Putting them into action will add value to everyone's lives.



Maureen McKenna

TRANSFORMING PUBLIC ATTITUDES TO MATHS

Our research and engagement work sought to understand negative public perceptions of maths¹ and how these could be addressed. We used online questionnaires and focus groups to obtain an indicative snapshot of how the public view and use maths². This included asking young people and adults “What does maths mean to you?” We received over 3,000 responses to our online questionnaire.

“We are all surrounded by things which rely on maths in one way or another. It is no exaggeration to say that maths is the language of modern life.”

Emeritus Professor Adam McBride,
University of Strathclyde

Both young people and adults used words such as “difficult” and “challenging”. Young people’s answers included ‘boring’ and “fun” in equal measure. In the adult responses, phrases such as “life skill” and “problem-solving” were prominent. The responses from adults often associated maths with work or everyday life but some suggested that their experiences at school had given them a negative attitude to maths.

Our research clearly highlights the factors that create negative public perceptions of maths. Maths is perceived as difficult and demanding. For some, this is linked to feelings of anxiety or inadequacy. Respondents used words such as “dread” or “fear of failure.” Some said that maths gave them a sense of “panic” and others that they “hated” maths. As we observed in our interim report³, maths is seen as highly judgemental: answers are either right or they are wrong. This can give rise to a sense of failure if a person answers wrongly and a reluctance to engage further to protect their self-confidence.

- 1 This report uses the term maths as encompassing the study of numbers, shapes and space. Maths as used in this report therefore includes the skills of numeracy and arithmetic.
- 2 Full details are available in the research and engagement paper available at <http://www.gov.scot/Topics/Education/Schools/curriculum/MakingMathsCountScotland>
- 3 Scottish Government, *Making Maths Count*, Interim Report (2016) <http://www.gov.scot/Resource/0049/00497342.pdf>

We explored attitudes to maths further in our focus groups and received the following views:

PRIMARY SCHOOL PUPILS FROM P4 TO P7

The majority of pupils made positive comments about maths. However, they would like maths to be more fun and involve more active learning. Despite their young age, pupils wanted to understand how maths will be useful for jobs and everyday life. They were also attuned to how their family members felt about maths, both positively and negatively. In some cases, pupils were able to give examples of difficulties that they had overcome with the help of a parent.

SECONDARY SCHOOL PUPILS FROM S1 TO S6

The young people in this group also wanted more to be done to explain why maths is useful for everyday life including specific aspects of maths such as algebra. Young people in this group tended to have narrower views than those in our other focus groups on the jobs which required maths. Their responses focused on STEM (Science, Technology, Engineering and Mathematics) careers and those in financial services.

PARENTS AND ADULT LEARNERS

Most of the adults in our focus groups wished that they had known when they were younger how much they would need to use maths in their daily lives including managing money and for work.

They suggested that it would be helpful to highlight the ways in which people already use maths probably without thinking about it and better than they might believe. This could help people to appreciate that they already have a skills-base in maths, remove some of the fear factor, and encourage them to further improve their skills. The adults in our focus groups also suggested promoting the message that being good at maths will bring you benefits whatever your interests in life.

These responses have helped us to identify both the challenges and opportunities in addressing negative public perceptions of maths. There are two main challenges. The first is to convince everyone, whatever their circumstances in life, that they have the ability to become proficient at maths. The second is to convince them of the benefits of doing so. The first challenge requires defining what we mean by proficient. This will vary at different stages in a person's life:

- For children and young people, being proficient in maths means achieving the expected benchmarks for each of the curriculum levels of Curriculum for Excellence. Crucially, this includes developing the skills⁴ of mathematical reasoning, resilience and understanding of key concepts. It will also mean progressing on to National Qualifications in mathematics.
- For adults, it means acquiring and maintaining the skills necessary for them to realise their potential in life and work.

4 Further information on maths skills as defined in Curriculum for Excellence and benchmarks for numeracy and maths is available in the following guidance from Education Scotland:
<https://education.gov.scot/improvement/Pages/num4numeracymathematicsskillsplr.aspx>
<https://education.gov.scot/improvement/Pages/CfE-delivery-plan.aspx>
<https://education.gov.scot/improvement/Documents/NumeracyMathematicsBenchmarks.pdf>

We are recommending that the Scottish Government works with partners to commission a sustainable culture change strategy for Making Maths Count. This should include further work on defining proficiency in maths.

The first challenge also involves confronting some deep-rooted cultural myths and assumptions, for example, the belief that some people are “naturally” or “innately” good at maths and others are not. The ideas from our respondents can help to confront these myths. Some of those who feel anxious about maths in a formal context, such as school or work, can be proficient in maths in other situations such as sports, shopping or cookery. Highlighting the different ways in which people already use maths can help to remove maths anxiety and encourage them to further improve their skills.

This approach can also help us with the second challenge – convincing people of the benefits of becoming proficient at maths. Our respondents emphasised the need to make maths more relevant to daily life and work. By doing so, we

can demonstrate that being proficient at maths will bring benefits whatever people’s interests in life.

We are already taking this approach in our communications work. We have engaged with individuals from across society who have positive stories to tell about maths and are promoting these via our blogs⁵. The blogs show how maths is essential to jobs as varied as creating computer games; jewellery making; managing a taxi business and zoo keeping; and leisure activities ranging from cookery to football. The blogs could be used as “conversation starters” with pupils, parents and the wider public about the benefits of maths.

As the case study below shows, we are bringing together schools and businesses to show how maths skills can be developed in new and enjoyable ways:

Our research, engagement and communications work has convinced us that creating a positive climate for maths in Scotland requires a long-term sustainable cultural change strategy. This leads to our first recommendation:

CASE STUDY

Balloch and Ardersier Primary Schools in Highland created maths expressions for flags for the Scottish Open Pro-Am Golf tournament. The initiative was supported by Aberdeen Asset Management and gave pupils of all ages the opportunity to develop their maths skills in a fun way. The pupils used different aspects of maths ranging from addition and subtraction to fractions and powers to create expressions for the flags. The initiative showed them how maths is used in real-life contexts such as sport.

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5 The Making Maths Count blogs are available on the following link:
<http://blogs.scotland.gov.uk/making-maths-count/>.

RECOMMENDATION 1

The Scottish Government should work with partners to commission a sustainable culture change strategy for Making Maths Count.

The strategy should:

- create greater enthusiasm for maths as a vital life skill amongst children and young people, parents and carers and the wider public; and
- promote the value of maths as an essential skill for every career and an economic imperative if Scotland is to compete internationally.

The strategy should be appropriately funded and have a strong focus on communications and improving public access to a range of maths information and resources including those for family learning.

We discussed a range of specific campaigns to promote maths taking place in the UK and overseas including Maths Week Ireland⁶.

CASE STUDY

Maths Week Ireland was established in 2007 and is an all-Ireland celebration of maths. The event promotes the awareness, appreciation and understanding of maths through a wide range of events and activities including maths puzzles and challenges. Some of these take place in everyday locations such as shopping streets and centres. Over a quarter of a million people participated in the 2015 event.

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6 Further information about Maths Week Ireland is available on the following link: <http://www.mathsweek.ie/>

We were impressed with the range of partners involved in Maths Week Ireland from education institutions to national and local government to the media. A strong feature of Maths Week Ireland is the long-term commitment made to

developing the initiative. Although Scotland has successful science festivals, we believe the nation would benefit immensely from an event focused specifically on promoting maths. This leads to our second recommendation:

RECOMMENDATION 2

The Scottish Government should work with partners to develop jointly and fund a Maths Week Scotland which brings together events across the country with online and hands-on experiences for young people, their parents and carers and the wider public.

It is essential that there is a broad collaboration between the Scottish Government, local government, education, business and other sectors

in commissioning a sustainable culture change strategy for Making Maths Count and developing a Maths Week Scotland.

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Our research and engagement work has shown the influence that parents and carers have on their children's attitudes to maths. Even the youngest children were attuned to how their family members felt about maths both positively and negatively. In the responses to our online questionnaire, the most common reason that adult respondents provided for wishing to improve their maths skills was to be able to better help

their children with their learning. In the best practice, nurseries⁷ and schools work closely with parents and carers to support their children's learning. However, there is scope to do more and take a more strategic approach linked to the widespread desire to make maths more relevant to everyday life and work. This will create greater enthusiasm for maths and help to raise attainment and leads to our third recommendation:

RECOMMENDATION 3

Each local authority should develop and implement a strategy to ensure that all schools and nurseries engage with parents, employers and others in their local communities to help children and young people develop greater awareness of the importance of maths to everyday life and future jobs.

Education Scotland and local authorities should collaborate to share and disseminate good practice.

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7 The term “nurseries” is being used in this report to refer to the range of early years settings.

IMPROVING CONFIDENCE AND FLUENCY IN MATHS FOR CHILDREN, YOUNG PEOPLE, PARENTS AND ALL THOSE WHO DELIVER MATHS EDUCATION

Improving confidence and fluency in the learning and teaching of maths is essential for creating greater enthusiasm and raising attainment. We considered how best to do this across a range of areas from tackling maths anxiety and improving progression pathways to enhancing teacher education and better supporting parental and family learning. This section presents our findings and recommendations in these areas.

“There should be no such thing as boring Mathematics.”

Professor Edsger Dijkstra,
computer scientist

School Education

Tackling Maths Anxiety

Our interim report highlighted findings from the 2012 PISA (Programme for International Student Assessment) survey contained in the OECD report *Improving Schools in Scotland: An OECD Perspective*⁸ that some 30% of Scottish learners reported that they feel very tense and nervous when doing maths work and more than 50% worry that maths will be difficult.

8 Organisation for Economic Co-operation and Development, *Improving Schools in Scotland: An OECD Perspective* (2015)
<http://www.oecd.org/education/school/Improving-Schools-in-Scotland-An-OECD-Perspective.pdf>

The anxiety levels reported by Scottish 15 year olds are similar to the OECD average and similar to those of Canadian, Irish and New Zealand students, but higher than the levels reported in the Netherlands and Norway. **The OECD recommended that the issue of maths anxiety in Scotland warrants close attention.** The OECD's report also highlights that girls are more prone to low self-confidence in ability to learn maths than boys, even when they perform at similar levels. This is an issue across OECD countries. Scotland is no different in this regard than elsewhere.

In addition, the 2015 SSLN⁹ survey indicates the need to improve learning and teaching to raise attainment in maths.

We believe that promoting a growth mind-set approach, and other methods of improving learner confidence such as positive learning dispositions, are essential to addressing maths anxiety and raising attainment. Promoting a growth mind-set means encouraging learners to understand that their abilities are not fixed and they can improve their skills through effort and dedication. This involves setting challenging but achievable goals and understanding where to obtain support when necessary. It also means learning from mistakes and using this experience to embrace new challenges.

These methods need to be a strong and explicit part of maths learning and teaching throughout early years and school education. This leads to our fourth recommendation:

RECOMMENDATION 4

All schools and nurseries should use a wide range of effective learning and teaching approaches to promote positive attitudes and develop high expectations, confidence and resilience in maths.

CASE STUDY

Lasswade Primary School in Midlothian has developed eight “Learning Superheroes” based upon learning dispositions and skills which have been demonstrated by research to play a role in the development of a growth mindset. So, for example, Tough Tina represents resilience and never giving up, while Curious Kevin instils in pupils the importance of asking questions and being inquisitive. The research was initially carried out with P1 pupils in 2014/15 and the approach has now been embedded across the school. Future plans include considering using the approach in the associated nursery.

Although the Learning Superheroes underpin learning throughout the school, they have particularly helped pupils develop mathematical resilience. For example, Mike the Mistake Maker models a growth mindset and encourages children to use mistakes as opportunities for learning. Learning Lola promotes an enthusiasm for learning in maths and encourages children to use a variety of strategies when faced with a challenge. One P3 pupil commented, “I love maths now because the Superheroes help me!”

9 Scottish Government, National Statistics *Scottish Survey of Literacy and Numeracy 2015* results
<http://www.gov.scot/Resource/0050/00500749.pdf>

Improving Progression Pathways in Maths

Research evidence¹⁰ and feedback from our focus groups emphasised the importance of ensuring good progression pathways in maths. Maths is a sequential subject and the learning achieved at each stage provides the foundation for the next stage.

To help achieve this, progression pathways should develop good understanding of, and confidence in:

- calculating mentally
- using appropriate mathematical language and notation
- applying key mathematical properties
- developing understanding about relationships between numbers and mathematical concepts.

Good learning and teaching should emphasise the connections between:

- different aspects of maths (for example, connections between topics such as shape, number and algebra)
- different representations of mathematics (for example, moving between symbols, words, diagrams, objects and graphs)
- learners' methods (for example, encouraging learners to explain their thinking and promoting collaborative learning).

Ensuring effective transitions between primary and secondary education is particularly important. This should include providing continuity and progression in learning through professional dialogue between staff and effective reporting of pupils' achievements including through P7 profiles. Consideration should also be given to developing joint Career Long Professional Learning (CLPL) activities particularly in relation to progression, assessment and moderation.

Currently, there is great interest in maths mastery approaches from South Asia. Professor Ruth Merttens¹¹ suggests that some of the general principles of these methods can be beneficial particularly for Scottish primary school education. However, Professor Merttens warns against adopting these methods wholesale as a “one-size-fits-all” approach. The general principles that Professor Merttens recommends are:

- a coherent approach to skills development and progression
- consistency in models, images and pedagogic vocabulary
- an emphasis on memorised facts to help learners develop a secure bank of memorised number facts to support them in making mental calculations and other aspects of maths
- “over-learning” – drawing repeatedly on fundamental concepts and key skills
- practising skills, strategies and methods to embed learning
- constant small interventions and differentiating learning with an emphasis on supporting pupils to achieve their best and ensuring that there are no gaps in learning.

10 For example, Maths Excellence Group report (2011) <http://www.gov.scot/Resource/Doc/91982/0114466.pdf>

11 Professor Ruth Merttens, *What Should Scottish Primary Teachers take from Shanghai and Singapore?* in *Scottish Mathematic Council Journal* 45 (2015) <http://www.scottishmathematicalcouncil.org/wp1/smc-publications/journals/>

We support these principles as key to improving learning and teaching and raising attainment.

Education Scotland is continuing to produce advice and support to help schools gain a deeper understanding of how learners can progress in maths in line with the experiences and outcomes for Curriculum for Excellence and help prepare learners for National

Qualifications in Mathematics. This includes benchmarks for numeracy and mathematics and the National Numeracy and Mathematics Progression Framework¹² available on the National Improvement Hub¹³.

However, further work is needed to improve the quality of learning and attainment. This leads to our fifth recommendation:

RECOMMENDATION 5

Education Scotland should evaluate the quality of children's and young people's learning experiences and attainment in maths and share examples of good practice.

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12 Benchmarks for Numeracy and Mathematics and National Numeracy and Mathematics Progression Framework (2016)

<https://education.gov.scot/improvement/Pages/num1nnpf.aspx>

<https://education.gov.scot/improvement/Documents/NumeracyMathematicsBenchmarks.pdf>

13 National Improvement Hub portal

<https://education.gov.scot/improvement>.

Interdisciplinary Learning

Interdisciplinary learning¹⁴ helps learners to make connections across different subject areas to deepen their understanding and apply their learning in different contexts. Feedback from our focus groups and other discussions indicates that there is significant scope to improve interdisciplinary learning with a maths context and at an appropriate level of challenge. This could cover STEM (Science, Technology, Engineering and Mathematics) topics or using maths and historical studies to investigate famous Scottish mathematicians and the impact of their work. It could also involve promoting cross-subject approaches to the use of particular aspects of maths such as statistics and graphs.

The Making Maths Count blogs can be used as a starting point for interdisciplinary learning as they cover issues ranging from the use of maths in sport and psychology to creating computer games to cookery. Interdisciplinary learning provides good opportunities to develop employability skills. The blogs contain examples of how maths is used in jobs ranging from engineering to marketing to beauty therapy.

Financial education topics also provide a strong basis for interdisciplinary learning. Education Scotland has produced resources¹⁵ for financial education that can be used within interdisciplinary learning.

Interdisciplinary learning needs to have clear purposes and learning outcomes and help learners develop their skills, knowledge and understanding of maths. STEMEC has produced advice¹⁶ on developing interdisciplinary learning within STEM subjects.

National Qualifications

The Group's interim report discussed entry figures and pass rates for National Qualifications in Mathematics. Initial results data for 2016 are now available¹⁷. These show a decline in entry figures for Higher Mathematics from 21,074 in 2015 to 18,868 in 2016. This contrasts with a rise in the entry figures for Higher English from 35,354 in 2015 to 36,356 in 2016. Our interim report highlighted the growing gap in entry patterns between Higher Maths and Higher English and it is disappointing to see this trend continue and increase with the latest figures. The total number of passes for Higher Mathematics also decreased in 2016 (13,863) compared with 2015 (15,169).

14 Education Scotland, link to guidance on Interdisciplinary Learning <http://www.educationscotland.gov.uk/learningandteaching/learningacrossthecurriculum/interdisciplinarylearning/index.asp>

15 Education Scotland, link to Financial Education resources <http://www.educationscotland.gov.uk/learningandteaching/learningacrossthecurriculum/responsibilityofall/numeracy/financialeducation/>

16 STEMEC (Science, Technology, Engineering and Mathematics Education Committee), Pillars and Lintels: The What's, Why's and How's of Interdisciplinary Learning in STEM Education (2014) <http://www.gov.scot/Topics/Education/Schools/curriculum/ACE/Science/STEMEC/STEMECPapers/PillarsandLintels>

17 Figures are for all entries and include both secondary schools and colleges. The figures are also pre-appeal/pre-review.

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More positively, both numbers of entries and number of passes increased for National 5 Mathematics. The number of entries increased from 36,475 in 2015 to 41,780 in 2016 and the number of passes increased from 22,536 in 2015 to 26,412 in 2016.

Our focus groups provided views from pupils and teachers on National Qualifications courses in Mathematics. Feedback from the focus groups indicates concerns over the amount of assessment within these courses. Pupils in S4 to S6 perceived Mathematics as different from other subjects in terms of the time pressures particularly at Higher level: “You are constantly moving from one thing to the next and it makes it difficult if you are struggling with a particular aspect; it’s also hard to remember what you have done and catch up if you fall behind.” They did however enjoy the

process of working out a problem and getting the right answer. The pupils thought that this was a more satisfying experience in Mathematics than other subjects that they were studying.

The pupils in our focus groups who decided not to pursue National Qualifications in Mathematics beyond S4 reported that they had lost confidence due to concerns over the potential volume of content and lack of time to absorb this material. Their perceptions of Mathematics contrasted with those of other subjects such as English which they believed to have a slower pace of learning. The perception of a faster pace of learning in maths meant that some pupils were concerned that there might not be enough time for them to receive the support they might need if they choose to pursue National Qualifications in Mathematics.

Teachers said that the pace of learning, coupled with maths anxiety, is creating difficulties for some pupils. They noted that the volume of assessment is curtailing the opportunities to consolidate learning. Some also expressed concern that the broad general education may not be preparing pupils for National Qualifications in Mathematics as effectively as possible.

Teachers surveyed in research¹⁸ by the Scottish Qualifications Authority (SQA) raised similar concerns: “The high volume of content is an issue in some subjects”. This was indicated in a number of centres – especially in subjects such as Maths, Sciences and History. Teachers also felt that there was a huge jump in the “step up” from National 4 to National 5, but less so from National 5 to Higher.

The Assessment and National Qualifications Group has been taking action to address these concerns. The Group brings together national and local government, teacher professional associations, SQA, Education Scotland and other partners. The Group’s remit is to make recommendations on:

- the policy framework within which National Qualifications are developed and operate
- assessment policy and practice from ages 3-18, and the best means of supporting improvements.

The Group’s first report provided a series of actions to reduce the assessment demands for National Qualifications. As part of this, SQA published individual subject reviews. In relation to National Qualifications for Mathematics¹⁹, the actions include introducing cut-off scores for unit assessments. Similar action has already been taken for Lifeskills Mathematics²⁰.

The Scottish Government’s Delivery Plan for Education²¹ includes commitments to explore further means of reducing workload demands associated with National Qualifications. We would encourage SQA to take account of the concerns of learners and teachers over the volume of content within National Qualifications for Mathematics.

The Mathematics Development Group is a practitioner-led group tasked with providing greater support for National Qualifications in Mathematics at National 5, Higher and Advanced Higher levels. This includes advice and support on:

- closing the gap for learners between National 4 and National 5 Mathematics
- aspects of National 5 Mathematics covering vectors, quadratics, straight line and Indices and surds
- aspects of Higher Mathematics including problem solving, indices and inverse functions.

18 SQA, *National Course Design and Assessment: SQA Fieldwork Visits* (2016) http://www.sqa.org.uk/sqa/files_ccc/SQA_Fieldwork_visits.pdf

19 SQA, *National Qualifications Mathematics Review Report* (2016) http://www.sqa.org.uk/sqa/files_ccc/Mathematics_Review_Report.pdf

20 SQA, *National Qualifications Lifeskills Mathematics Review Report* (2016) http://www.sqa.org.uk/sqa/files_ccc/Lifeskills_Mathematics_Review_Report.pdf

21 Scottish Government, *Delivering Excellence and Equity in Scottish Education: A Delivery Plan for Scotland* (2016) <http://www.gov.scot/Resource/0050/00502222.pdf>

The Group has also provided support for Lifeskills Mathematics at National 5 level in relation to the geometry measures unit.

The materials are available on the National Qualifications site on Glow – the digital environment for Scottish schools and educational establishments. Education Scotland’s National Numeracy and Mathematics Hub is also promoting and supporting use of the resources.

Initial Teacher Education

Our focus groups included discussions with students in Initial Teacher Education covering primary school teaching and secondary school teaching in maths and other subjects.

The students in our focus groups were generally positive about their tuition. Those on ITE courses for primary school teaching would like to have more of their course time dedicated to maths. The students on ITE courses for secondary school maths teachers had degrees either in maths or with significant maths content and therefore felt well prepared in teaching the content of maths courses. The students would find it helpful for ITE courses to include more of a focus on how teachers can better understand and support children’s thinking processes in maths. The students on ITE courses for secondary school teaching in other subjects believed that they had sufficient maths skills to cover maths-related content in their subjects which ranged from Geography to Business Studies to Science.

The views expressed in our focus groups are reflected in the findings of a much wider survey of the views of current probationers and early careers teachers undertaken as part of an evaluation report on the impact of the implementation of Teaching Scotland’s Future²². The majority of current probationers and early careers teachers surveyed felt that numeracy (and literacy) were adequately covered during ITE – more so in primary than in secondary. However, as with all aspects of ITE, respondents felt that more practical strategies would be beneficial. Respondents were asked their views on how useful they found different aspects of their ITE courses in helping to prepare them for their first teaching post. With specific reference to the numeracy aspects of ITE courses, 56% of the 903 respondents said that this had been useful or very useful; 20% said that it had been neither useful nor not useful and 21% reported that it was not useful or not at all useful.

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22 *Evaluation of the Impact of the Implementation of Teaching Scotland’s Future* (2016) <http://www.gov.scot/Resource/0049/00495434.pdf>

Currently, the minimum entry requirements to ITE courses in Scotland are for applicants to have attained a National Qualification in Mathematics at SCQF (Scottish Credit and Qualifications Framework) level 5 (e.g. National 5 or Standard Grade Credit or Intermediate 2 level). The current requirement in relation to English is for applicants to have attained a National Qualification Course award at SCQF level 6 (e.g. Higher level).

The General Teaching Council for Scotland (GTCS) plan to begin a review of minimum entry requirements in January 2018 with revised requirements due to be published in June 2018 to have effect for the ITE intake in August 2019. We would wish this review to consider the case for raising the minimum entry qualifications for Mathematics to the same level as that for English.

The students in our focus groups did however express some concern if the minimum entry requirements for maths were raised to SCQF level 6 as this would preclude some of them from entering teaching. They suggested that online testing of applicants' maths and numeracy skills and/or greater use of subject specific entry requirements would be better than raising minimum entry requirements in general. These options should be considered as part of the review.

The content of ITE courses is not prescribed centrally but decided by individual institutions themselves subject to accreditation by the GTCS. We need our primary teachers in particular to be more confident and skilled in the teaching of maths.

These issues lead to our sixth recommendation:

RECOMMENDATION 6

The GTCS, in partnership with Initial Teacher Education Institutions, Education Scotland and local authorities, should undertake research on how well ITE students are being prepared to teach maths as newly qualified teachers. The research should include a review of:

- Minimum entry requirements to ITE for Maths.
 - Other means of ensuring applicants have good quality maths skills, e.g. online testing of applicants' numeracy skills.
 - The extent to which there is sufficient coverage of maths in primary ITE programmes to allow meaningful, quality maths learning in primary schools.
 - The means by which ITE institutions continuously update and improve their programmes and provide a practical focus on teaching and learning styles that instils teacher confidence in delivering maths.
 - The extent to which the probationary year promotes good quality teaching and learning styles and improving confidence in maths.
-

Career Long Professional Learning

International evidence supports the view that teachers benefit from enhanced Career Long Professional Learning (CLPL) opportunities to increase their confidence and professional practices in teaching maths. For example, the European Commission's Eurydice network report *Mathematics Education in Europe: Common Challenges and National Policies*²³ states that participation in CLPL opportunities can have a substantial impact on teachers' "work, their achievement, skills and attitudes as well as on their performance and job satisfaction." Furthermore, "an overwhelming amount of research evidence shows that teachers' professional development has a positive effect on student achievement."

In relation to the content of CLPL activities, the report highlighted research findings that the most effective approaches "went beyond generic pedagogy by providing teachers with a range of mathematics-based content and teaching methods that were specific and exclusive to mathematics."

Successful activities "shared an emphasis on developing students' conceptual understanding of mathematics and encouraged multiple approaches to mathematical problem-solving." They also "developed not only teachers' understanding of their students' mathematical thinking but also their ability to evaluate it."

In Scotland, there is a range of support that local authorities and schools can draw upon to provide CLPL specific to maths. This includes resources on the National Numeracy and Mathematics Hub - a virtual learning environment, administered by Education Scotland and accessed through Glow. There are also opportunities through partnerships with universities including formally accredited learning at SCQF level 11 (often referred to as "masters" level learning). The Professional Update process provides a chance for teachers to consider their CLPL needs and opportunities.

Local authorities are developing their approaches to providing effective CLPL for teachers in maths as exemplified by the following case study:

CASE STUDY

Fife Council's Pedagogy Team helps to develop primary school teachers' skills in improving pupils' conceptual understanding and confidence in maths. There is a particular focus on improving outcomes for the most vulnerable learners. The team uses baseline and diagnostic assessments to identify pupil needs and progress. Teachers are encouraged to provide greater opportunities and support to pupils to talk about maths. This helps to boost pupils' mathematical understanding, memory, reasoning and language development. Pupils are circulated round different groups to facilitate greater interest and promote peer learning. The Team also supports teachers working across clusters with associated schools and nurseries to promote professional dialogue in maths teaching and learning.

23 Eurydice, *Mathematics Education in Europe: Common Challenges and National Policies* (2011) [https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Publications:Mathematics Education in Europe: Common Challenges and National Policies](https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Publications:Mathematics_Education_in_Europe:_Common_Challenges_and_National_Policies)

We believe that there is a clear case for further enhancing CLPL provision for maths. This should be aimed at assisting staff to promote more engaging teaching styles; developing and consolidating key concepts in maths; logical thinking (e.g.

problem solving); promoting growth mind set approaches in relation to maths and highlighting the relevance of maths to everyday life and work. This leads to our seventh recommendation:

RECOMMENDATION 7

All sectors of education should promote access to high-quality career-long professional learning (CLPL) to increase staff confidence and enhance professional practices in teaching maths to children, young people and adult learners. Each local authority should design, implement and evaluate the impact of a CLPL strategy for teachers and community learning staff to develop their professional practices in teaching maths.

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Family Learning

Our online questionnaire asked respondents if they would like to improve their maths skills. Fifty-eight per cent (1446) of adult respondents said that they did. The most common reason that they gave for wishing to improve their skills was to better help their children with their learning.

Parents participating in our focus groups, and meetings with parental organisations, showed a similar desire to better support their children's learning in maths. They also highlighted the barriers they faced. Some lacked confidence in their own skills and found it difficult to access the help they needed. Others were unsure about how maths is currently taught in schools and worried about confusing their children by showing them the "wrong" methods: "Parents can be nervous about trying to help in case they are teaching them something in a way which conflicts with how they're doing it at school." Some reflected upon their own experiences at school and how this created problems for them in helping their own children: "The maths department at my school was scary. I didn't like maths. Still don't like maths."

The parents recognised that their children are attuned to the feelings of family members about maths. Some sought to hide their lack of confidence by encouraging their children to seek support from other family members. Others told their children how important maths is for everyday life and work. Some of these parents wished that they had received similar advice when they were at school: "Maths is in everything. I wish I had known this sooner, if I had I might have stuck with maths at school."

Some parents stressed the need for schools to make maths more relevant and enjoyable for their children. They would welcome greater outreach activities and engagement work including homework clubs that parents or other family members such as grandparents could attend with their children. This would help them to better understand how schools are currently teaching maths.

The following case study provides an example of the work taking place to support family learning in maths:

CASE STUDY

Glasgow City Council has introduced Play-a-long Maths in more than 30 early years and primary establishments across the city. Staff have had considerable success in engaging parents in a closer partnership, through providing the children and parents with games and activities to play at home. Play-a-long Maths is a language-based programme which uses a variety of games and activities to encourage parents and children to play together 10-15 minutes a day, 5 to 6 days a week for 6 to 8 weeks. The children choose a different game each week and the parents have weekly sessions with school staff to discuss their experience of the game. The aims for the child include the building of a mathematical vocabulary and mathematical concepts by providing experiences of the mathematical language of sorting, grouping and relationships.

Other support available for parents includes the *Parentzone*²⁴ and *Read, Write, Count*²⁵ websites.

Support for adults who wish to improve their maths skills is available through community learning providers, colleges and a range of websites. We will consider in the section on “Maths as an Essential Skill for Employment” how government, national agencies and employers can work together to further improve adult maths skills and therefore benefit parents.

The opinions that parents expressed in our focus groups and meetings are reflected in international research. The Eurydice report *Mathematics Education in Europe: Common Challenges and National Policies*²⁶ states that “Parents should be encouraged to help their children to learn

and enjoy mathematics. Moreover, the involvement of parents is vital for the success of intervention programmes. At the same time, in view of the data on the level of adult numeracy skills, it should be recognised that some parents might not be able to provide adequate support for their children’s learning.”

As discussed earlier, our third recommendation is that each local authority should develop a strategy to ensure that all schools and nurseries engage with parents, employers and others in their local communities to help children and young people develop greater awareness of the importance of maths to everyday life and future jobs. Education Scotland and local authorities should collaborate to share and disseminate good practice.

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24 Link to Parentzone website

<http://www.educationscotland.gov.uk/parentzone/>

25 Link to “Count” section of Read, Write Count website

<http://www.readwritecount.scot/count/>

26 Eurydice, *Mathematics Education in Europe: Common Challenges and National Policies* (2011) https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Publications:Mathematics_Education_in_Europe:_Common_Challenges_and_National_Policies

Scottish Attainment Challenge

The Scottish Attainment Challenge has been set up to improve educational outcomes in communities with a high concentration of children living in poverty. There is a specific focus on improving literacy, numeracy and health and wellbeing. Initial support has been directed at primary schools in seven local authority areas (Glasgow, Dundee, Inverclyde, West Dunbartonshire, North Ayrshire, Clackmannanshire and North Lanarkshire). The programme was extended in June 2016 to include secondary schools and two further local authorities (East Ayrshire and

Renfrewshire). Funding for the Scottish Attainment Challenge has also been increased to £750 million over the next five years.

The Group welcomes this additional support which will help many more children and young people develop their maths skills. Early indications are that in the first year many of the primary schools involved have taken a focus on improving literacy. However, it is essential that schools take account of all three priorities during the lifetime of the programme, and this leads to our eighth recommendation:

RECOMMENDATION 8

Schools supported by the Attainment Scotland Fund as part of the Scottish Attainment Challenge should increase their focus on raising attainment in numeracy and include parental engagement as part of their plans.

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MATHS AS AN ESSENTIAL SKILL FOR EMPLOYMENT

Improving maths skills for employment

Maths is an essential skill for every job. There are a myriad of ways in which maths is used in employment: handling financial transactions; estimating costs, floor spaces and materials; measuring medicines, food and drink supplies, hair dyes; understanding data and statistics; calculating computer coding; using algebra in engineering and geometry in transport and logistics; dealing with payslips, tax and national insurance – the list is endless.

“In a world where technological advances are accelerating, mathematical illiteracy is a recipe for economic decline.”

Martin Gilbert,
CEO, Aberdeen Asset Management

This means that poor maths skills are a direct drag on the economy. A report²⁷ in 2014 by Pro Bono Economics undertaken for National Numeracy estimated the cost to the UK economy of outcomes associated with low levels of numeracy to be around £20.2 billion per year, or about 1.3% of GDP.

It is essential that our workforce is confident and fluent in maths if Scotland's economy is to continue to compete internationally.

Many employees are of course parents, and developing their maths skills would also help them to better support their children's learning.

Some work is taking place to improve maths skills for employment. This includes National Numeracy's work with employers.

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27 Pro Bono Economics Report for National Numeracy, *Cost of Outcomes associated with low levels of adult numeracy in the UK (2014)*

<https://www.nationalnumeracy.org.uk/cost-outcomes-associated-low-levels-adult-numeracy-uk-2014>

CASE STUDY

National Numeracy, a UK independent charity that helps to improve numeracy skills amongst young people and adults, has been working with a range of employers to carry out Numeracy Reviews²⁸ of their staff. The Numeracy Review allows an in-depth insight into numeracy levels and attitudes to maths amongst the workforce, and provides strategies for improvement.

As part of the Numeracy Review, National Numeracy asks employees to complete a short attitudinal survey to explore their attitudes, belief and values around maths. Following on from this, employees are asked to complete the National Numeracy Challenge Check-Up to provide an accurate record of their current numeracy levels. Qualitative focus groups are also held which explore this relationship further and help understand some of the barriers to numeracy that exist across the workplace.

It is clear however that much more needs to be done if we want to develop Scotland as a thriving economy that can meet the challenges of the future. For example, there is a growing recruitment crisis in the STEM sector where specific and often higher order maths skills

are required. Evidence²⁹ suggests that young adults in the UK lack knowledge of the many career paths dependent on STEM qualifications, despite the wide range of employers consistently calling for these skills. This leads to our ninth recommendation:

RECOMMENDATION 9

To help raise Scotland's skills base and promote our economic competitiveness, Skills Development Scotland, Education Scotland, Scottish Funding Council and other relevant partners should work with employers, colleges and schools to develop an action plan for improving maths skills for employment. This should include a focus on adult learners both as workers and parents. One approach could be to commission an online tool and associated in-work support to help adults test and improve their maths skills. As well as those in work, the action plan should also consider support for those seeking work.

28 National Numeracy – Numeracy Review

<https://www.nationalnumeracy.org.uk/numeracy-review>

29 A.T. Kearney in association with the Your Life campaign, *Tough Choices: The real reasons A-level students are steering clear of science and maths* (2016)

<http://1cwcpp2qp6hi1exr69469mgu.wpengine.netdna-cdn.com/wp-content/uploads/2016/06/YL-ATK-Tough-Choices-Research-Report-FINAL-3-02-16.pdf>

Developing the Young Workforce

The Scottish Government established the Commission for Developing the Young Workforce in 2013 to consider:

- how a high-quality intermediate vocational education and training system, which complements our world-class higher education system, can be developed to enhance sustainable economic growth with a skilled workforce;
- how to achieve better connectivity and cooperation between education and the world of work to ensure young people at all levels of education understand the expectations of employers, and that employers are properly engaged; and
- how to achieve a culture of real partnership between employers and education, where employers view themselves as co-investors and co-designers rather than simply customers.

The Commission published its report³⁰ in June 2014. This included the recommendation that “A focus on STEM (Science, Technology, Engineering and Mathematics) should sit at the heart of the development of Scotland’s Young Workforce.”

The Scottish Government published its response *Developing the Young Workforce – Scotland’s Youth Employment Strategy*³¹ in December 2014.

As part of the strategy, a network of up to 21 industry-led regional groups is being set up to:

- encourage and support employers to engage directly with schools and colleges
- challenge and support employers to recruit more young people into their workforce.

We contacted the regional groups that had been established by Spring 2016 for their views on how best to promote maths as an essential skill for employment. We received replies from seven groups (Fife; Moray; North East Scotland; North Highland; Perth and Kinross; West Lothian and West College Region.) The groups provided a range of examples of how employers are engaging with schools to develop maths skills. The employers involved range from engineering and construction to digital technology to financial services.

The following case study provides an example of the work taking place:

30 Scottish Government, *Commission for Developing the Young Workforce* report (2014) <http://www.gov.scot/Topics/Education/developingtheyoungworkforce/background/commissionreportresponse>

31 Scottish Government, *Developing the Young Workforce – Scotland’s Youth Employment Strategy* (2014) <http://www.gov.scot/Publications/2014/12/7750>

CASE STUDY

In the North East of Scotland, the Score Group PLC – an engineering business – has supported schools in creating a Saturday Maths Club. The initiative, which is delivered in an “employer/work” context, helps to ensure that pupils who are committed and interested in apprenticeships have a set of basic skills. Exercises are delivered by staff using real engineering drawings and materials. The programme is delivered free of charge to young people and is designed and run by Score volunteers who are all STEM registered. The programme currently operates in Peterhead and is available to pupils in fourth year and above in the catchment area.

The regional groups are at the outset of their work and could only provide initial views on the future action that should be taken. Some groups suggested that there remains a lack of knowledge and awareness amongst employers on how best to engage with schools and colleges. Their view was that links tend to be developed as a result of individual personal relationships between employers and teaching staff rather than a strategic approach.

To help address this, the Scottish Government has produced guidance³² for school/employer partnerships. This guidance provides a useful basis for employers, primary and secondary schools and colleges to work together to demonstrate the benefits of maths for future careers. There is however a need to take further action to ensure that children and young people are aware of the many and varied careers that good skills in maths can open up for them and be inspired to take these opportunities. This leads to our tenth and final recommendation:

RECOMMENDATION 10

The network of Developing the Young Workforce Regional Groups should be asked to contribute to the development and implementation of the action plan proposed in recommendation 9 in relation to school/employer engagement to promote maths as an essential skill for employment. This should cover primary as well as secondary schools.

32 Scottish Government, *Guidance for School/Employer Partnerships, Guidance for DYW Regional Groups and Local Authorities*
<http://www.gov.scot/Publications/2015/09/8676/downloads>

CONCLUSION

The Scottish Government tasked us with developing recommendations to encourage greater enthusiasm for maths amongst children and young people, their parents and carers and the wider public.

We have met this remit by providing 10 practical, cost-effective recommendations to transform Scotland into a maths-positive nation. Our remit has been wide-ranging and so are our recommendations.

We have proposed a sustainable culture change strategy to **transform public attitudes to maths**. This includes the development of a Maths Week Scotland event.

We have set out a series of actions to **improve confidence and fluency in maths**. These range from making maths more relevant to everyday life and future careers to increasing proficiency in maths and improving initial teacher education and career-long professional learning.

We have set out an ambitious approach to promote maths as an **essential skill for every career** bringing together employers, national agencies, schools and colleges.

Each of these recommendations is necessary to address the negative attitudes towards maths that is holding Scotland back in the world. Implementing all of them can drive our nation forward educationally and economically. It all adds up if we want to give Scotland a bright future.

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GROUP'S REMIT

Aim – Encourage greater enthusiasm for mathematics amongst children and young people; their parents and carers and the wider public.

Key issues

- The Group should seek to better understand negative public perceptions in relation to mathematics and how these can be addressed. There should be a particular focus on creating a more positive environment for mathematics teaching and learning in schools, helping parents and carers to support their children in developing greater skills and confidence in mathematics and increasing skills levels for employment.
- The Group should recommend practical, cost-effective approaches to encouraging greater enthusiasm for mathematics amongst young people and their parents and carers.
- The Group should consider how best to address the areas for development for learners identified through the Scottish Survey of Literacy and Numeracy and other sources.

MEMBERSHIP

Maureen McKenna – Chair – Executive Director of Education, Glasgow City Council

Professor Tara Brendle – Glasgow University, School of Mathematics

Billy Burke – Headteacher – Renfrew High School

Dr Sandra Cairncross – Edinburgh Napier University

Joe McLachlan – National Parent Forum for Scotland

Peter McNaughton – Head of Education and Children's Services, Fife Council

Sean Phayre – Aberdeen Asset Management

Dr Heather Reid – Glasgow Science Centre

Caroline Stuart – Independent Director

NATIONAL MATHEMATICS DEVELOPMENT GROUP

As part of Making Maths Count, the National Mathematics Development Group, with a membership including maths teachers, principal teachers and faculty heads, was tasked with providing greater support for National Qualifications in Mathematics at National 5, Higher and Advanced Higher levels. The materials are available on the National Qualifications site on Glow – the digital environment for Scottish schools and educational establishments. Education Scotland's National Numeracy and Mathematics Hub is also promoting and supporting use of the resources.

SUMMARY OF ORGANISATIONS AND GROUPS PROVIDING EVIDENCE

Developing the Young Workforce Regional Groups – Fife, Moray, North East Scotland, North Highland, Perth and Kinross, West Lothian and West College Regions

Education Scotland’s Curriculum, Learning, Teaching and Assessment Forum involving teacher and local authority representatives from Dumfries and Galloway, Fife, Glasgow, Inverclyde, North Lanarkshire and Shetland

Mathematics Development Group involving teachers from Aberdeen, Angus, Argyll and Bute, East Ayrshire, East Dunbartonshire, East Lothian, East Renfrewshire, Falkirk, Fife, Glasgow, Inverclyde, Highland, Moray, North Ayrshire, Scottish Borders, South Ayrshire and South Lanarkshire. A college lecturer and Quality Improvement Officer from Edinburgh were also involved

Maths Week Ireland

National Numeracy

National Parental Engagement Steering Group involving the following organisations: Al Qalam School, BEMIS Scotland; Comann nam Parant; Education Scotland; Enquire; Families Need Fathers; Families Outside; National Parent Forum Scotland; Parent Network Scotland; Save the Children; Scottish Catholic Education Service; Skills Development Scotland; Scottish Government; Scottish Qualifications Authority; Scottish Parental Involvement Officers Network; Scottish Parent Teacher Council

Scottish Qualifications Authority

Scottish Mathematics Council

ONLINE QUESTIONNAIRES AND FOCUS GROUPS

2,508 adults submitted a questionnaire response. Fourteen of these were removed because none of the questions had been answered, leaving 2,494 responses for analysis. 828 children and young people submitted a questionnaire response. Two of these were removed because none of the questions had been answered, leaving 826 responses for analysis.

Focus groups were held at nine locations. These included two primary schools and one secondary school where discussions were held with pupils, teachers and parents; two colleges where discussions were held with students and staff; two universities where discussions were held with students involved in initial teacher education; a group of business representatives and those involved in adult basic education.

Further information is available in the research and engagement paper at <http://www.gov.scot/Topics/Education/Schools/curriculum/MakingMathsCountScotland>



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