



more maths grads
multiplying opportunities

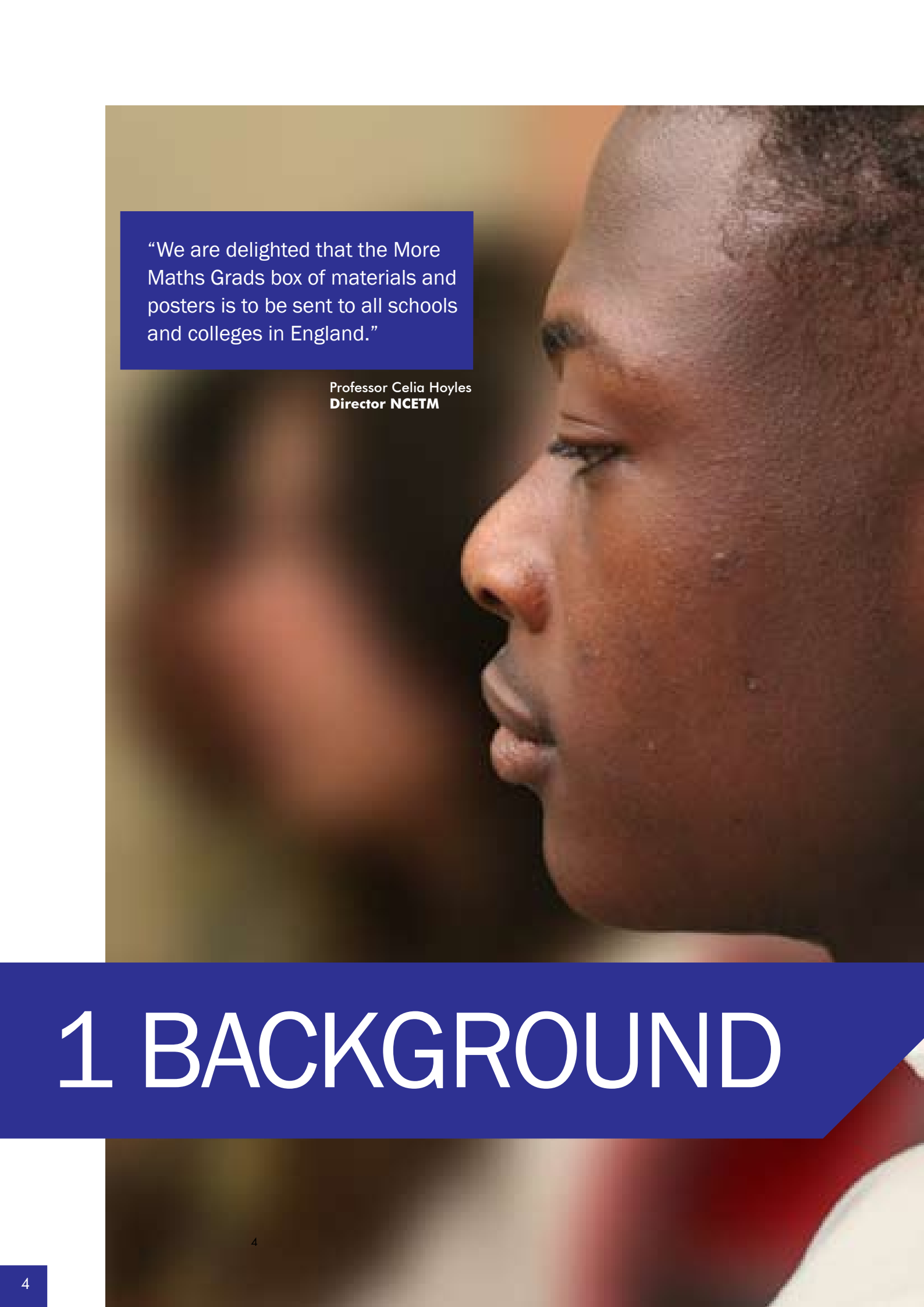


More Maths Grads /
2007-2010 /
Final Report



Contents

1	Background	p4
2	The proposal	p6
3	What we did	p8
3.1	The student theme	p8
3.2	The teaching theme	p10
3.3	The careers theme	p10
3.4	The higher education curriculum theme	p12
4	The Welsh adventure!	p14
5	Success!	p16
6	Conclusion	p18



“We are delighted that the More Maths Grads box of materials and posters is to be sent to all schools and colleges in England.”

Professor Celia Hoyles
Director NCETM

1 BACKGROUND

Background

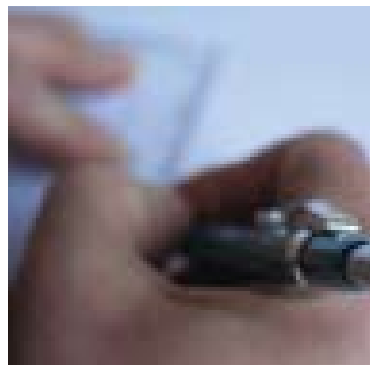
The More Maths Grads (MMG) project had its origins in 'SET for Success' [1] the report of Sir Gareth Roberts' review of the supply of people with science, technology, engineering and mathematics skills

An important conclusion was that the disconnect between the strengthening demand for graduates (particularly in highly numerate subjects) on the one hand, and the declining numbers of mathematics, engineering and physical science graduates on the other, was starting to result in skills shortages. A number of issues which relate to mathematics were identified in the report, in particular shortages in the supply of mathematics teachers; the ability of courses to inspire and interest students; and poor, or lack of, careers advice. Also the proportion of girls studying the subject post-16 was considerably lower than boys and there were concerns that ethnic minorities were under-represented on higher education mathematics courses.

The government responded rapidly to the review and published its response as 'Investing in Innovation: A Strategy for Science, Engineering and Technology' in July 2002 [2]. Based on the contents of this document the then Secretary of State for Education, Charles Clarke wrote to the Chairman of the Higher Education Funding Council for England (HEFCE) in December 2004. In this letter he requested advice on 'whether there are any higher education subjects or courses that are of national strategic importance, where intervention might be appropriate in order to enable them to be available'. Helpfully the Secretary of State gave a list which included science, technology, engineering and mathematics, and STEM was born.

The next part of the story took place in April 2005, when John Rushforth, then Director of Widening Participation at HEFCE, addressed the Heads of Department of Mathematical Sciences (HoDoMS) conference, on protecting mathematics in higher education.

As a result of an intervention by David Youdan, Executive Director of the Institute of Mathematics and its Applications (IMA), HEFCE made funding available to prepare a bid to their Strategic Development Fund for a project to increase the take-up of mathematical sciences in higher education, whilst at the same time widening participation. A consortium was quickly formed consisting of the IMA, the London Mathematical Society (LMS), the Royal Statistical Society (RSS), HoDoMS and the Higher Education Academy's Maths, Stats and Operational Research (HEA-MSOR) support network and chaired by Professor Duncan Lawson representing HoDoMS. Two consultants sought the views of the wider mathematics community and gathered the evidence on under-representation in higher education participation which would support the bid. Based on this evidence they also identified potential partners to enable the delivery of the project activities in pilot regions.



2 THE PROPOSAL

The proposal

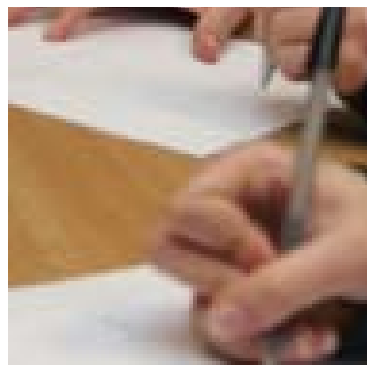
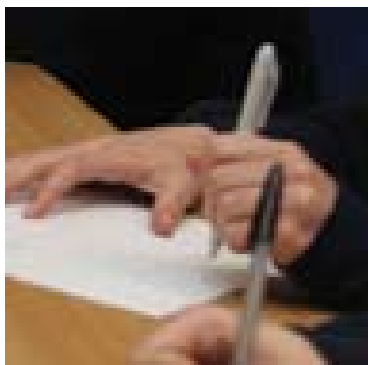
The overall aims of the proposed project were:

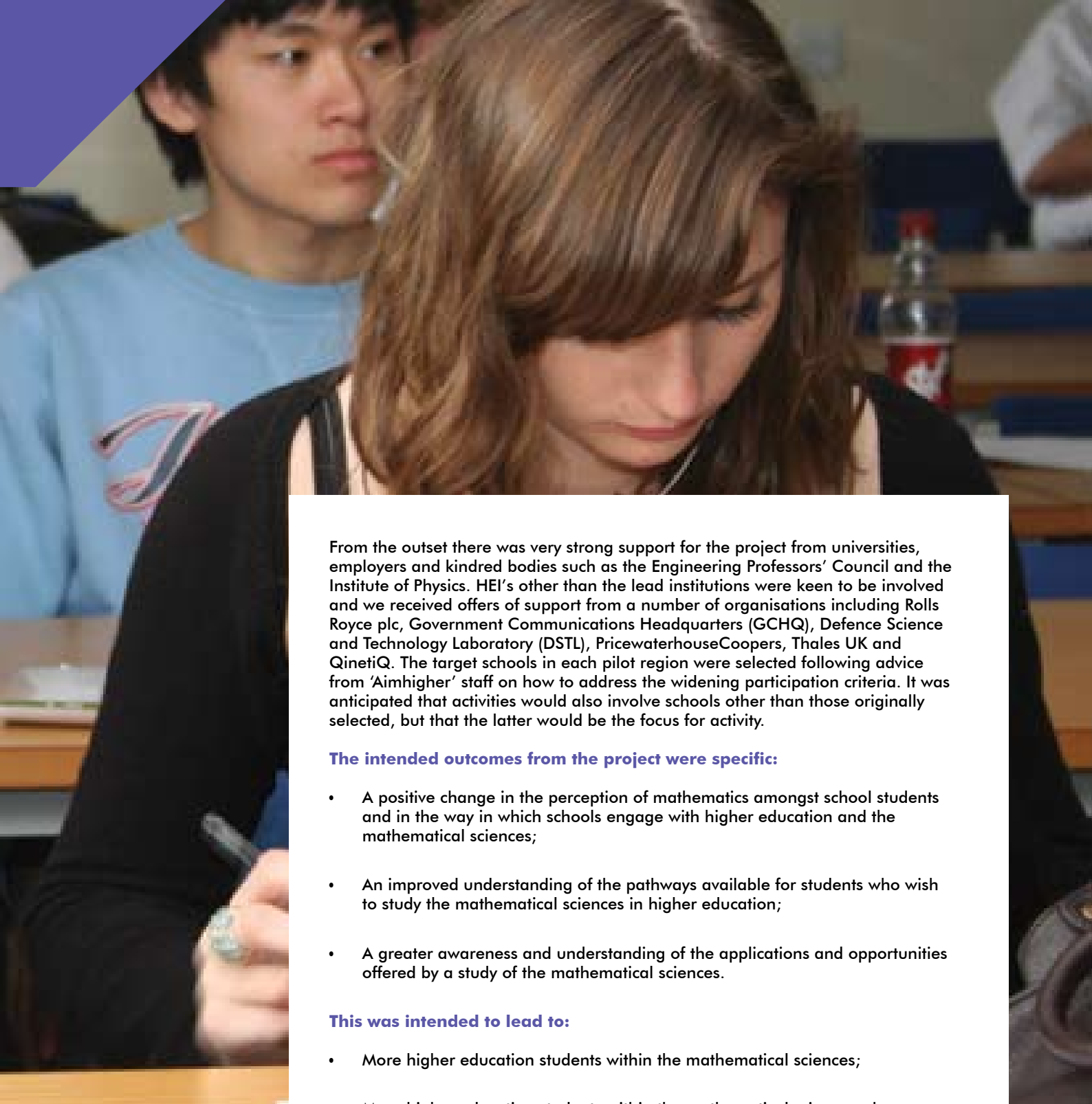
1. To widen participation within the mathematical sciences from groups of learners who have not previously been well represented in higher education.
2. To increase the supply of mathematical science graduates in England so that the demands of industry, commerce and education might be better met.

The proposal was to embed, within three designated regions, four aspects of support for school and college students to gain, and then sustain, interest in the mathematical sciences and to encourage them to study the mathematical sciences in higher education. The four strands of activity proposed were:

- **Student theme:** Enrichment activities, aimed directly at students to encourage them to raise their aspirations and attainment levels in the mathematical sciences and to consider the study of mathematical sciences in higher education.
- **Teaching theme:** Support for mathematics teachers to enable them to raise the aspirations and the attainment level of their students.
- **Careers theme:** Promotion of information about the wide-ranging relevance and applicability of mathematics and the breadth of career opportunities open to graduates from the mathematical sciences.
- **Higher education curriculum theme:** A review of the nature of the higher education curriculum in the mathematical sciences to ensure that it is suited to a wide range of students.

Three pilot regions were selected for action, namely the West Midlands, Yorkshire and Humberside and London. Three lead higher education institutes (HEIs) were involved: Coventry University, University of Leeds, and Queen Mary, University of London. Regional coordinators were found from amongst the permanent staff of these HEIs and two project officers were appointed to work exclusively on designing and delivering project activity. Sheffield Hallam University was also involved and concentrated on the higher education curriculum theme. The base for the project was Birmingham University where members of the HEA-MSOR network provided strategic direction to support the project manager and his assistant who were also based there.





From the outset there was very strong support for the project from universities, employers and kindred bodies such as the Engineering Professors' Council and the Institute of Physics. HEI's other than the lead institutions were keen to be involved and we received offers of support from a number of organisations including Rolls Royce plc, Government Communications Headquarters (GCHQ), Defence Science and Technology Laboratory (DSTL), PricewaterhouseCoopers, Thales UK and QinetiQ. The target schools in each pilot region were selected following advice from 'Aimhigher' staff on how to address the widening participation criteria. It was anticipated that activities would also involve schools other than those originally selected, but that the latter would be the focus for activity.

The intended outcomes from the project were specific:

- A positive change in the perception of mathematics amongst school students and in the way in which schools engage with higher education and the mathematical sciences;
- An improved understanding of the pathways available for students who wish to study the mathematical sciences in higher education;
- A greater awareness and understanding of the applications and opportunities offered by a study of the mathematical sciences.

This was intended to lead to:

- More higher education students within the mathematical sciences;
- More higher education students within the mathematical sciences who are young women, students from the lower socio-economic groups, minority ethnic students and adult learners;
- More students who are young women, students from the lower socio-economic groups, minority ethnic students and adult learners enrolled upon higher education courses with a significant mathematical component, for example, economics, physics and engineering.

The intention was to provide evidence that a coordinated and structured approach could lead to an increased flow of students into the mathematical sciences and other courses with a strong mathematical component.



3 WHAT WE DID





What we did

In order to explain how the project was delivered we consider the individual themes in turn.

3.1 The student theme

Throughout the project, the officers aimed to show young people the wide-ranging applicability of mathematics and to break down the barriers and misconception that mathematics was an irrelevant subject. Throughout the project, we worked closely with a number of organisations. Our Yorkshire and Humberside project officers, based at the University of Leeds, worked closely with the National Centre for Excellence in the Teaching of Mathematics (NCETM) and focussed on innovative ideas, for example, creating 32 video clips that highlighted the diverse uses of mathematics in the world of work (Maths at Work Mpegs are available in DVD format and at the Maths Careers website, www.mathscareers.org.uk). The collection has become a powerful resource in teaching functional mathematics and underlining the relevance of mathematics in the workplace. Video resources were also created by project officers in London and by the central project management team in Birmingham; the Alumni Project Mpeg focuses on former students acting as maths ambassadors to inspire students. The video also shows the ways in which mathematics is used in a diverse range of career paths.

The 'What's the point of ...?' series has also been well received by teachers as a tool to engage students in a dynamic and innovative way. The project has established that it is important to keep linking mathematics to applications and careers to enable students to identify with the real life contexts in which mathematics is used. It is for that reason that the London region organised 15 workshops covering applications from music and technology to 'maths in chocolate'. Similarly, Leeds University organised a range of workshops that highlighted the use of

mathematics in unique settings; they worked with employers on describing the mathematics involved in drug trials and went on to find out from a freelance costume designer why mathematics underpins her work. Coventry University also extended this major learner theme when a full lecture theatre of guests were intrigued by a presentation given by Dr. David Acheson who explained the link between 'Mathematicians, Magic and the Electric Guitar'.

London-based officers also worked with NRICH, a project based at Cambridge University; together they set up visits from various schools to the university to highlight the applicability of mathematics in a range of educational settings and also in various career paths. Year 8 students were entertained by engaging them in particular experiments in fluid dynamics and in making catapults, for example. Leeds University hosted similar events with students from various schools and with differing abilities visiting the University. It is evident from comments such as 'it gave me a reason to do maths' and '[it] encouraged me to take higher maths', that the days were a success and that the project was going a long way to meet its objectives.

Our experiences and internal evaluations have shown that role models such as HEI undergraduates and early-career professionals played a vital role in changing perceptions of mathematics as a subject. (We were always seeking to use non-traditional role models, for example, women working in engineering.) MMG has created career profiles that follow the path of an individual and their experience with mathematics throughout their educational and professional lives. These profiles reflect on the many routes by which one can enter a mathematics-orientated career and have been produced as a booklet which is also available electronically on the Maths Careers website.



“The project’s legacy should prove to be a valuable resource.”

David Youdan
Executive Director IMA



3.2 The teaching theme

The theme for teachers was a minor theme, nevertheless having close links with both the student theme and the careers theme. Resources produced by these themes added value to the classroom and have consequently added a new dynamic to support teachers. At the close of the project we feel very strongly that there is so much more that needs to be done for teachers in terms of providing either financial or practical support particularly to enable them to attend more enrichment events. The project has continued to link local HEI undergraduates with schools to assist teachers within the classroom and in other activities.

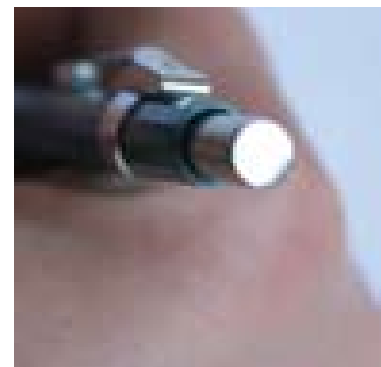
MMG received support from the Ogden Trust to provide residential schools for teachers. In addition, the project pointed teachers to the NCETM web portal and to the work of other bodies such as the Mathematical Association (MA) and the Association of Teachers of Mathematics (ATM).

3.3 The careers theme

A large amount of maths careers literature was produced by the project teams, highlighting the opportunities open to graduates from the mathematical sciences. The Maths Careers website is the main target for these and other project outputs in order to better ensure their longevity. All careers resources have now been added to the website and are readily accessible as (free) downloads for students, teachers, careers advisers, parents and others.

Large-scale careers fairs were attended by the teams over the course of the project and these proved to be highly successful in terms of changing attitudes and perceptions towards mathematics. These also provided excellent opportunities to direct teachers, parents, employers and students to the website and, as an aid to this, all MMG marketing merchandise carried the website address. Our careers stands were highly interactive with mathematics puzzles, games and activities. Such activity has proved invaluable in holding attention and thus giving opportunities to highlight the applicability of mathematics. The project officers were in no doubt that visitors to the MMG stands were often surprised by the diversity of career opportunities on display.

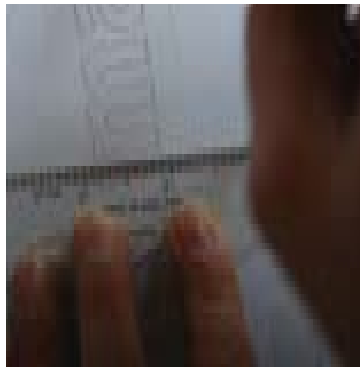
In order to develop careers resource materials specifically for careers advisors and mathematics teachers we worked with the Career Development Organisation (CRAC). Three workshops were delivered (one in each region) in conjunction with CRAC. A resource pack has been created as a tangible outcome, building heavily on the expert mathematics knowledge of the project officers.



“From the needs in the school classroom and the university lecture theatre, through mathematics research and computational science to the broader involvement of mathematics in everything from engineering design to insurance actuarial work, the campaign has championed the discipline.”

Sir Peter Williams
Former Chair of ACME and Oxford Instruments





3.4 The higher education curriculum theme

Work under this heading involved various activities. One of these was the gathering, categorising, digesting and analysing of data on the student experience of mathematical degrees, and staff perspectives on that. Another was an examination of the curriculum, learning, teaching and assessment, and support on mathematical degrees, primarily through the lens of student experience but also through staff perspectives. Both of these activities utilised data from two questionnaires, one taken in induction week at four universities and the other through all years of courses; data from some 35 interviews and focus groups of students and staff; and factual data gathered from various sources.

Another facet of this theme was an examination of the situation as regards adult returners to mathematical study, followed by an investigation into the feasibility of employer engagement with foundation degrees in the mathematical sciences.

Dissemination of the findings of our work both to the mathematical community and the wider group which includes potential students and their advisers was vital and a variety of means was used. A sequence of articles and discussion papers was prepared and some of these have already been published in 'MSOR Connections' and 'Mathematics Today'. All of these were later gathered together in a 'Good Ideas Guide'. This guide was enriched by interspersed case studies contributed by experts and innovators in particular relevant areas. Amongst other resources, this material will be available via the HEA-MSOR website. Other means of dissemination included talks at conferences including those of HoDoMS and HEA-MSOR and some of the talks have been videoed and distributed using YouTube. Finally a 'Maths@University' booklet has been prepared jointly with the LMS for wide distribution in schools and colleges, to help potential students understand the different types of mathematics courses.

4 THE WELSH ADV

The Welsh Adventure!

In 2008 the Higher Education Funding Council for Wales (HEFCW) encouraged MMG to bid for funding to deliver a pilot project in Wales. The project was to be smaller and over a shorter timescale than the England project but nevertheless would provide opportunity for giving real returns.

The Welsh Adventure began in December 2008 and was divided into two parts, in the first place translating all resources produced by the English project into Welsh, followed by 'Think Maths'.

In November 2009 our translated resources were sent to all secondary schools, further education colleges, universities and educational partners in Wales in the guise of 'More Maths Grads in a Box'. The entire project team was excited to be able to collect all of MMG's combined efforts into a tangible output and share it with the wider educational community.

The second part of the project, 'Think Maths', was aimed at creating partnerships between schools, employers and HEI's in Wales. Our remit was to create five partnerships in both North and South Wales in an effort to give students an insight into how mathematics is used in context by both

undergraduate students and in industry. The project actually secured thirteen partnerships, eight in South Wales and five in North Wales, and in each case students who had taken part were challenged with tasks based on their experience. All participating schools prepared case studies that focussed on these tasks in preparation for an inter-school competition at the 'Think Maths' finale events held at prestigious venues in both North and South Wales. The North Wales finale took place on the shore at Caernarfon. We invited the five school-employer partnerships to take part, and it was repeated on the next day. The South Wales finale was held at the Millennium Stadium in Cardiff, with the eight school-employer partnerships and Swansea and Cardiff Universities.

In all cases the students exceeded our expectations and produced some excellent work. We were particularly impressed by their confidence in South Wales, where they made their five-minute presentations in front of almost 300 people! It was also clear that many students would now consider taking mathematics further. The events were a huge success for MMG, the schools, the employers and the universities. All of the organisations gave positive feedback and are keen to maintain close links with MMG.

VENTURE!



5 SUCCESS!



Success!

It is our impression, backed up by both internal and external evaluation, that the MMG project has been very successful. Indeed we believe that we have contributed in some way to the 20,000 increase in the number of A level mathematics entries and perhaps also to the 15% increase in enrolments on to mathematics courses in higher education in 2009. One important indicator of our awareness-raising success is the rapidly increasing number of hits on the Maths Careers website.

Rather than list evaluation evidence here, a number of people were invited to comment on their impression of the success of the project, and some of these are included below.

5.1 Sir Peter Williams, Former Chair of ACME and Oxford Instruments

MMG has successfully targeted in recent years both the critical importance of, and the ongoing need for, more mathematics graduates in all walks of life in society. From the needs in the school classroom and the university lecture theatre, through mathematics research and computational science to the broader involvement of mathematics in everything from engineering design to

insurance actuarial work, the campaign has championed the discipline. MMG was established following the decline in numbers studying mathematics at all levels and worked with others to raise the profile and relevance of the subject; we are now beginning to see something of a renaissance. But the job is not yet done, and the National HE STEM programme, based at Birmingham, needs encouragement from us all to continue the excellent work of More Maths Grads.

5.2 Professor Celia Hoyles, Director NCETM

The National Centre for Excellence in the Teaching of Mathematics (NCETM) has been very pleased to collaborate with the MMG project to enhance engagement with mathematics across the whole landscape, by for example chairing the advisory group. We are delighted that the More Maths Grads box of materials and posters is to be sent to all schools and colleges in England and look forward to promoting these excellent resources as well as supporting regional projects and engagement with employers showing 'maths in action'.

5.3 David Youdan, Executive Director IMA

I am so pleased that the More Maths Grads project has been such a success. Every element, in particular the talents and energies of the delivery team, has been excellent. When the Higher Education Funding Council for England



wrote to me in 2004, they asked if the IMA would be able to lead on a mathematics outreach project. I replied that it would be better if a consortium of the mathematics organisations could work together. When I later suggested to HEFCE that we needed some seed funding to kick-start our ambitions, the project was born.

Mathematics has been vital in every phase of my career. The design of a coal mine; the stability of rock slopes in Asia; finding cracks in water pipes in Africa; the stability of a North Sea oil platform in a gale; calculating the settlement of the airport runway and the motions of suspension bridges in Hong Kong: these are tasks that I have enjoyed working on where we could not have succeeded without the power of mathematics. In all the projects it has been significant that mathematics was present at many levels from the school stage to university undergraduate level and beyond.

Mathematics teaches us to be logical and numerate, to solve problems, to understand shapes and to use data. With mathematics we have endless opportunities. That is why this project aimed at increasing the number of mathematically skilled graduates has been so important. The project's legacy should prove to be a valuable resource.

5.4 Rt Hon Charles Clarke MP

The future of mathematics education remains vitally important for this country. I am delighted that the MMG Project has been able to make an impact in improving standards of mathematics

education and increasing the number continuing to study mathematics after 16. I hope that the experience of the project will be carefully considered as future policy is formed.

5.5 Professor Madeline Atkins, Vice-Chancellor, Coventry University

I am delighted that Coventry University has been so strongly represented in the management and delivery of the highly successful MMG project. This important initiative has been focussed on increasing the interest in, and demand for, courses in the mathematical sciences in higher education. This is vital work given the importance, and also the potential vulnerability, of the discipline. At Coventry we are proud of our mathematics provision, not just our high quality research work but also our focus on teaching and learning including 'SIGMA', a HEFCE-funded Centre for Excellence in Teaching and Learning in university-wide mathematics and statistics support. This centre plays a key role in helping students from across a range of STEM (and other) disciplines succeed in the mathematical components of their studies.

I recently served on Alan Milburn's panel which reported on fair access to the professions. This panel's report, 'Unleashing Aspiration', identified a number of issues in the area of professional outreach that need urgent attention. The report commends the use of visits by employers to talk about particular careers and what they mean in practice. Organising school visits to employers is also thought helpful in this respect. Visits to schools by current undergraduates and those in the early stages of a career is also seen as a good way of providing information on higher education study and subsequent employment. It is pleasing to note that several of the activities within MMG directly address some of these issues, with an emphasis on widening participation. MMG was always intended to be a pilot project operating in a few areas of England. This pilot activity has demonstrated that universities can play an effective role in bridging the gap between schools and employers enabling school students to gain a much richer understanding of the wide ranging applicability of the mathematical sciences to a host of different careers through direct interaction with those actively using mathematics in the workplace. I sincerely hope that this ethos and many of the ideas that have been validated by MMG will be taken forward by the National HE STEM Programme.

6 CONCLUSION


Conclusion

MMG activity ends on 31st January 2010, but this is not the end of the story!

Following the well-received trial run in Wales, all resources produced during the course of the project and much more, will be sent as 'More Maths Grads in a Box' to all secondary schools, further education colleges and universities in England. The box will also contain the means to reproduce all MMG material for future needs. By this means we leave a legacy of mathematics resources for those delivering the Birmingham-led National HE STEM Programme to draw upon. MMG and the other pilot projects have blazed a trail and we wish the new project every success.

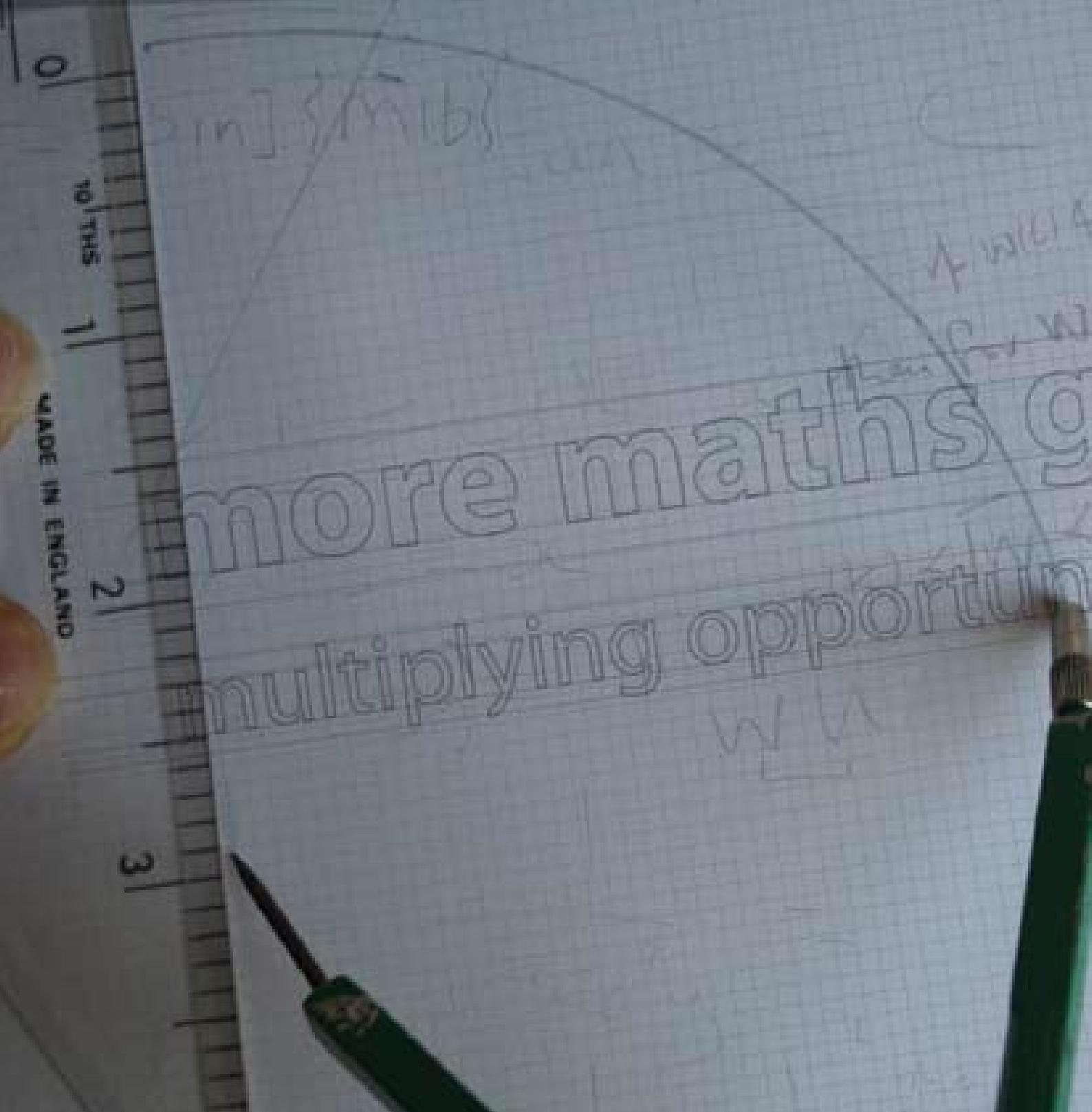
References

- [1] 'SET for Success' The supply of people with science, technology, engineering and mathematics skills. HM Treasury April 2002
- [2] Investing in Innovation: A Strategy for Science, Engineering and Technology. HM Treasury July 2002.

A close-up photograph of a hand holding a green pencil, drawing a large, stylized letter 'S' on a sheet of graph paper. The pencil is positioned vertically, with the tip touching the paper. The background is slightly blurred, showing other drawing tools like a ruler and another pencil. A pink rectangular box is overlaid on the image, containing a quote.

“I hope that the experience of the project will be carefully considered as future policy is formed.”

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