Progressing through mathematics

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I could not resist combining the theme of BCME7 (Mathematical Progressions) with some thoughts on my personal journey and a focus on how mathematics can enable people to progress in so many areas. I like the double meaning tied up in the conference theme. It not only relates to some very interesting mathematics but also shows how mathematics enables progression in many areas. I am going to indulge myself on the way with some glimpses into my own journey through mathematics and the influences on the choices I made. I will also explore such influences more widely, as well as possible implications for teaching, learning and professional development.

Before I influence you with my thinking, I would like us all to focus on personal influences and to think for a moment on something or someone that really excited or inspired you in mathematics: maybe a pivotal moment?

As this talk continues I would like you to reflect on this and be thinking about what we are doing, and might do, to excite young people these days. I have been extremely fortunate in my career to have worked with, and learnt from, many outstanding teachers and educators. Preparation for this talk has afforded some happy reminiscences, so I may indulge myself a little which I hope you will forgive.

I would however, at this point like to make particular mention of one person who has influenced my thinking in more recent years and that is the late Doug French. Doug's untimely death last year touched so many people and everyone I have met who knew him has an anecdote about something Doug did that had a huge impact on their teaching or thinking. He worked tirelessly for mathematics education, and the MA were privileged when he was our president three years ago. All of the attributes that my talk associates with being an excellent teacher fit Doug perfectly.

I would like to start by showing you a video of one of the heroes of mathematics: a teacher. The video shows part of an A Level lesson about trigonometrical identities. The teacher has been working on a project in which she is trying out approaches to engage the class in discussion and to encourage them to do the mathematics for themselves. In this part of the lesson the teacher asks the class to vote on which of the expressions on the board are identities and which are not. Without revealing the answers, she asked them to focus on the ones where there was no agreement in the class and to work in small groups to try to prove whether or not they are identities. The rest of the extract follows some of the discussions and the teacher's questions to one of the groups*. 

* The video is available as part of the presentation of this talk on www.bcme7.org. In addition there is a short video of the teacher reflecting on the ways she was now adopting for teaching.

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It is an interesting time to be talking about mathematics: we are less than a month from an election and maths is one of the political footballs – if not the main one in education. Why is mathematics so important?

Perhaps one of the issues we have is that everyone feels they have expertise in mathematics because they have experienced the teaching of it, or because they use it, or just because they recognise the importance. Whatever the reason, they all have an opinion and thus decisions are often taken either by those lacking subject specialism or based on evidence from those who lack such specialism. There has never been a greater need for the mathematics community to speak in a united way.

As noted by Sir John Holman, STEM Director, the ‘demand for highly numerate & analytical individuals is predicted to grow much faster than for those with other skills’. However, such skills are in short supply. According to the CBI education and skills survey 2008, ‘59% of employers are having difficulty recruiting enough STEM-skilled individuals to meet their needs’.

The shortage is at all levels: ‘Without functional literacy and numeracy skills, people will find it increasingly difficult to do their jobs effectively and to progress to the higher levels of skills that the UK’s prosperity will increasingly depend on.’[1]

Research also suggests that the need for mathematical skills and understanding is life-enhancing. ‘Men and women with poor numeracy skills at age 30 were more than twice as likely as those with competent numeracy to be unemployed’,[2]. However, even if people recognise a need to develop such skills, “for people with poor numeracy, the biggest barrier to participation is fear rather than complacency”, [2].

Mathematics seems to be like exercise; it is widely acknowledged to be good for you. Everyone can engage at their own level, it involves struggle and practice and we feel better for it! I actually prefer the analogy to music, possibly because I enjoy the product more. How many music teachers stop learners from trying to play an instrument or singing a song before they have learnt their scales and arpeggios? The sound may not be judged as good, but at least they have a feel for where they are going and a need to struggle on.

I do not think there is anyone in the room who would disagree that mathematics is vital, even if we would not go quite as far as Marcus du Sautoy in suggesting that ‘understanding mathematics is the difference between life and death’ [3], I suspect we also would come up with some common points as to why it is vital, though would we agree? Would we be talking about the same animal? What is mathematics?

And would we agree on the solutions to the issues around mathematics? One of the richesses of my roles, particularly in recent years, has been working with the range of passionate and committed people who all want to solve the problems of mathematics but struggle to find common solutions.

There is a thread on the NCETM portal ‘What is mathematics?’ [4] that attracted a wide range of views of which the following are just a sample. Mathematics is:
• a way of learning involving numbers and letters to solve equations and a wide variety of real life problems;
• used to quantify and explain the real world;
• a global language and provides the tools for our societies in using and developing science, technology, economics, etc;
• applying taught methods to solve given problems in life;
• producing a strategy to solve a problem, with or without applying a known technique;
• a logical and unique way of looking at the world. It can tell us how an aeroplane flies or explain the beauty of a flower.

You might like to consider whether or not you agree with any of these, or what you might write. I found this later posting particularly thought-provoking and felt it resonated with my own thinking:

My current thinking is that relationships and patterns are there naturally. The ratio of the circumference of a circle to its diameter isn’t a human construct, but nor is it maths!

I think that maths is the process you go through in order to notice the relationship between these things, to see and understand the patterns, to try to make sense of what’s around us and beyond. Without people there could be no maths because, to me, maths is a process, not a result. [4]

Not that I intend to debate issues and solutions today, but to try to bring out the richness of how mathematics enables people to progress in so many areas and how we might convey both the joy and importance of the subject in the classroom.

I occasionally wonder why I decided to be a maths teacher. I confess I was one of those people who enjoyed mathematics but then did not really know what to do with it; an issue that still prevails, even in this age of information overload and despite so many people trying to resolve it. Maybe I did not have a view of what mathematics was? I certainly did not understand what mathematics teaching was about.

So, where do I begin? I have been trying to think about what sparks there were for me as a girl. I think I was fairly typical – not over confident, but enjoying the subject and finding I had some sort of aptitude. So why did I enjoy it? Looking at all the studies now, I can see I was nurtured.

Neither of my parents had studied mathematics beyond school, though both used it, but also both had high expectations and did not stereotype my sister and me as girls. So, despite having a father with a strong literary bent, both my sister and I studied mathematics, further mathematics and physics at A Level and then mathematics at university (possibly connected with our mother’s mathematical genes!).

Friends inevitably shared some of my interests, though I do not know yet how much they influenced me, and at school it was also not especially
strange to want to study mathematics at school. I went to a girls' school. Numbers taking A Level were not great in any subject, but mathematics and physics held their own, and my sense was that any interest in that direction was positively encouraged.

It was at school that I first encountered Mathematical Pie. What excitement as we were given each new edition! I vividly remember this cover and spending weeks doodling such pictures on all available surfaces.

I loved the mixture of serious mathematical problems and silliness that were, and still is, in Pie.*

* The 8 blocks of digits at the bottom of the page are from the expansion of π. This was a feature of Pie for many years.
A STRIKING PROBLEM

If a clock takes six seconds to strike six, how long does it take to strike (1) eleven and (2) twelve?

FRUITY REMARK

What happens if you count apples in two's?

R.H.C.

THE LATEST JAZZ GROUP?

Logarithm (say it slowly)

R.H.C.

School is also where I began to recognise how crucial individual teachers are to real engagement in mathematics. I was taught by a number of enthusiastic and talented people. I think a real spark was ignited at A Level when we were actually doing the maths. What do I mean by this? Well, there was less of the teacher showing us how to do examples and expecting us to work in similar ways. We talked about problems together and struggled over them and even had the joy of working sometimes as equals with the teacher. I was also taught mechanics by an engineer. This was the first time I had seen objects hurtle across the mathematics classroom (in the cause of learning, at least!).

We even used to read the textbooks and find them interesting and engaging. Good text books still exist – Anne Watson has described the exercises and activities in them as ‘seductive’ – but how many of them are used regularly in schools? Teachers are under a huge amount of pressure to use the text produced by the awarding body and written by the examiner, often without the time to reflect on whether they are the best for the students.

So why did I not know what I could do with mathematics? I suspect there were a number of factors, not least that there was much less pressure on us to know where we might be going post-university. But I also think that my teachers, other than perhaps the engineer, did not have a good understanding of the skills which a strong mathematical education imparts. I can remember gaining a much stronger grasp of where sciences might take me, but resisted the call to be a chemical engineer...

Apart from this, the main careers advice was teaching, nursing, or the civil service: all good careers, but hardly encompassing the breadth that mathematics supports. Has this changed? Do we add ‘accountancy’ now? There are many good initiatives, such as mathscareers.org.uk, but most rely on teachers either having a knowledge of careers or researching outside their long teaching hours. What can we do to ensure that teachers, and others offering on careers advice (often themselves fearful of mathematics) really understand the wealth of pathways that mathematics can take you along?
How many understand the economic advantages of studying mathematics? A study in 2005 showed that ‘Mathematics is the only A Level subject that adds to earnings – by up to 10% - even when the employer is unaware of the person’s qualifications’ [5]. And there is further evidence to be found in looking at gross additional lifetime earnings (wage premiums) by degree subject compared to two or more GCE A-levels:

![Graph showing earnings by subject](image)

What professional learning is needed to support teachers, and others, in understanding what mathematics offers and where it might take you? This is beyond offering enhancement and enrichment for students. It involves making the links between such activity and the professional learning of teachers. How might such activity influence their practice, rather than be a bolt-on activity for students at the end of term?

Returning to my journey, off I went to university to study mathematics without really knowing what I had let myself in for, and soon realising that I was a very small fish in a large pond.

I am reminded of a student I taught many years later on an Access to HE course. He was a clever, articulate man, attracted by the notion of studying mathematics, but with no formal background in the subject. He had to learn the language of mathematics almost from scratch in order to express his ideas. Some of the work he produced was fascinating, demonstrating high level thinking, and he was gripped by the subject. When I asked him what he had expected the course to be like, he said that at junior school he had learned multiplying, dividing and at secondary school had learnt long division and long multiplication and he had assumed that mathematics would continue in this way, with the calculations becoming harder. He had gained no understanding of the power of the subject before.

I won't wander off into a reverie of nostalgia around university life which, after all, did involve a bit more than mathematics. However, I did come back to needing to make a decision about my future and, if I am honest, the attraction of a PGCE was equalled by the opportunity for an extra year in an environment I loved.
If I had expected an easy year, I was very wrong! However, this was when I had the good fortune to encounter the Mathematical Association again. My tutor at Durham, one Mike Cornelius, a former Chair of the MA Council, informed us in the first lecture that we could not be mathematics teachers if we did not join the MA! How true this was for me. If there are any teachers reading this who have not yet joined a subject association, those of us who have can only commend the opportunities offered, particularly being part of a community of professionals.

I was so naive about teaching, somehow assuming that my enthusiasm would rub off. Of course, enthusiasm is definitely a plus! But it was a shock to the system to realise how much there was, and still is, to learn.

I have mentioned a few, possibly unsung, heroes on the way. It was not until I started teaching and stopped worrying about sharpening the chalk and which colour to use, that I realised there were two key sets of heroes for me readily at hand.

Firstly there were the students themselves. In my first role, I was asked to teach the students applying to Oxford and Cambridge, on the basis that I had only just graduated myself, so all the mathematics would be familiar. It should have been, but they actually needed help with statistics, which I had left behind pre-A Level. Nonetheless, I prepared diligently and thought I was on top of it all. Dare I say, I even enjoyed it? A few years later, I met a couple of these early charges in a pub. They told me how much they had enjoyed my lessons. Before the glow wore off, however, they also told me that they had understood very little.

Another piece of early learner feedback that had a considerable impact on my teaching was the student who declared that she learned more when I didn’t know the answer. This does not offer an excuse to stop preparing, but does suggest that students learn best when we stop leading them to the answer.

The second group of heroes are the other professionals. I valued the opportunities to network, talk, share, make sense of things, and try new ideas out and feedback to colleagues. This is another essential element of professional learning.

We seem to have fallen into a rut in the last 10-15 years, possibly related to the drive to ‘raise standards’, have ‘measurable outcomes’, achieve the target grades, etc. A brilliant young teacher (Ronnie George, Brighton and Hove Sixth Form College) spoke to ACME last year and likened this to a bowling alley with fences down both sides, and where exams are the target. There is no chance to break out and this leads to what she described as a vicious cycle.
What such pressure does is to leave everyone striving for the model lesson. It engenders the belief that there is a way of teaching that will achieve exactly the outcomes we hope for. As Cockcroft reported, this is nothing new:

‘... We are aware that there are some teachers who would wish us to indicate a definitive style of teaching mathematics but we do not believe that this is either desirable or possible.

... Because of the differences of personality and circumstance, methods which may be extremely successful with one teacher and one group of pupils will not necessarily be suitable for use by another teacher or with a different group of pupils’. [6]

The “Mathematics Matters” review [7] conducted by the NCETM affirmed this belief that there are underpinning principles on which mathematics educators agree, but that these look different in different classrooms.

The review [7] said teaching is more effective when it

• builds on the knowledge learners already have;
• exposes and discusses common misconceptions and other surprising phenomena;
• uses higher-order questions;
• makes appropriate use of whole-class interactive teaching, individual work and cooperative small group work;
• encourages reasoning rather than ‘answer getting’;
• uses rich, collaborative tasks;
• creates connections between topics both within and beyond mathematics and with the real world;
• uses resources, including technology, in creative and appropriate ways;
• confronts difficulties rather than seeks to avoid or pre-empt them;
• develops mathematical language through communicative activities;
• recognises both what has been learned and also how it has been learned.

I can say for one, that if there was a single model, I would not be a teacher, and I am sure I am not alone! That there is not, however, emphasises the real need for career-long professional development in order that teachers are to develop their practice in such a way that they understand such underlying principles, what makes them mathematics-specific, and how they can be interpreted in classroom practice.
The review identified a number of barriers to such classroom practice, even though all involved felt it was desirable.

Society's attitude towards mathematics

Society and its media still promote mathematics as a 'geeky' subject and mathematical incompetence remains socially acceptable.

Teachers' subject and pedagogical subject knowledge

Many teachers lack confidence in the subject and an awareness and understanding of appropriate approaches and resources (including ICT). They also lack time for continuing professional development.

A taught curriculum defined by assessment

Assessment should be defined by the curriculum aims, rather than the taught curriculum being defined by assessment. Teaching towards national tests and public examinations has led to an overemphasis on 'covering content' in a superficial manner, at the expense of developing deeper understanding and non-routine problem solving. This is, at least partly, due to the fragmented and artificial nature of many of these assessments.

The style and quality of textbooks and other resources

There is still an over-reliance on pre-packaged schemes in all phases. Many of these, particularly those targeting specific assessments, do not promote the types of learning educators value.

Initiatives that appear conflicting, disempowering and prescriptive

A simplistic interpretation of national strategies and the apparent inflexibility and mechanistic nature of inspection regimes (particularly internal ones), can lead to the production of externally acceptable forms of behaviour (e.g. 3-part lessons, learning objectives written on the board before the lesson) and inhibit principled, imaginative teaching. Teachers report that inconsistencies often appear between the practices sought by inspections internal to their organisations (often by non-specialists) and those that are recommended by outside agencies. [7]

I suggest that a number of recent developments have de-skilled rather than up-skilled teachers, even though that was never the intention. Those of us who have worked with developments such as SMP, MEI, SMILE and others developed our practice and the skills to evaluate resources and textbooks, and we had the time to do so. The success of these initiatives was not so much in what was produced as in the development of the teachers themselves. It takes a very confident teacher now to move away from a scheme, to explore evidence from research or to develop their own ideas.
We need to support all teachers in this throughout their careers. There was a clear recommendation in [7] that "... continuing professional development should become an entitlement and expectation for all teachers. Effective, collaborative professional development should focus both on developing subject and pedagogical knowledge, rather than on the mechanics of implementing the latest 'initiative'. Professional development should be characterised as reflective teachers researching their own practice and engaging with the research of others.”

This was echoed in a recent paper from the Advisory Committee for Mathematics Education where it is stated that “......any new curricula innovation or initiative should be anchored from the outset to appropriate CPD that is couched in terms of developing the necessary subject knowledge and subject-specific pedagogy.” [8]

But I believe that pressures are greater now and more and more non-specialists are deciding what should be taught and how. As I have suggested, mathematics is a big political football. Even where good ideas and local successes become national initiatives, they often lose the support and character of the pilot phase.

Earlier I used the term “career-long professional development”. This is because I prefer this expansion of CPD to “continuing professional development” as it embraces the whole continuum from initial teacher education. Of course, we need to think about what is appropriate CPD. What is there specifically about mathematics that we need to develop?

To respond to this I would like to return us to what we do in the classroom, or wherever we are teaching mathematics. This again links to my own progression. It took me some time to realise the advantage of finding ways of enabling learners to do the maths themselves, rather than me doing it while they watched and listened. I felt somehow I owned the maths content and it was my duty to impart it to them. I think I knew there was every chance that many of my charges were potentially much more able in mathematics than me, and that was exciting, but I am not sure that early on in my career I responded to that knowledge. Nor do I think I had the belief that is firmly in my mathematical creed now, that all learners are capable of grappling with mathematics. We are too quick to label the ‘can do’ and ‘can’t do’, and there is so much evidence to suggest that these labels stick, that we pass our own anxieties and concerns on to others, possibly far more than we pass on our confidence and enthusiasm.

This firm belief that all learners, not just the high attainers, can do mathematics is exemplified in “Deep Progress in Mathematics” [9] where it states that “there are two aspects to low attainment in mathematics: not knowing enough mathematics and not knowing how to learn mathematics.” The teachers in the project believed that “all students can think hard about mathematics and thus do better at mathematics.” This relates to the notion that it is the learner who should be doing the mathematics in the lesson, not the teachers.
The “What is Mathematics?” debate on the NCETM portal has moved into a discussion about teaching methods [10]. Here some responses claim that “Good teaching is…”

- being able to engage with all of your audience and pass your knowledge of a particular subject on to them in a way they will understand and remember correctly;
- putting someone in a situation in which they are challenged to consider what they believe, to make connections and ultimately, to construct their own understanding;
- being able to involve the whole class and giving each student an equal opportunity to grasp a topic and understand it so that every single student can take something positive away from the lesson;
- empowering students with the skills, knowledge and confidence to tackle problems both inside the classroom and out.

The range possibly reflects experience, but I believe it also reflects beliefs.

Students in a recent NCETM report [11] were asked what they thought made a good teacher of mathematics. “The answer given in nearly all cases was that of exhibiting the dual professionalism of being good at their subject and having a concern about effective pedagogy. Good teachers of Mathematics were expected to have very high expectations of their pupils and to communicate those expectations in ways that encouraged self-confidence in the subject. Pupils had a high regard for the abilities of their teachers, spoke warmly about their approachability and were confident of receiving help and support in their learning.”

Their responses link to Ofsted’s view about good teachers of mathematics. [12]

Furthermore this links to what we mean by subject-specific CPD. There are three main strands to this: mathematics subject knowledge, mathematics-specific pedagogy and embedding these in practice. All three need to be addressed throughout career-long professional development.

I regard myself to have been enormously fortunate to teach in further
education (FE) for over half my career. In practice, though, for me this meant further education colleges, not the wider field that I have come to know in my more recent career. Working with learners covering a huge range of attainment, confidence, interest and motivation, as well as with some of the most creative teachers I have ever met. The experience also convinced me that we must develop pathways to support mathematics through to 18.

FE offers a second chance for so many learners, including the nearly 50% of 16 year olds each year who do not achieve GCSE grade C and regard themselves as failures in mathematics. There is an argument to suggest that many learners who do not achieve grade C are the most disenfranchised mathematically. Why? Because we offer them little more than either the chance to take the qualification over and over, or a mechanistic approach to key skills, or no mathematics at all. For me, the ideal offering would be a credible alternative to going through the GCSE course again (and again...), though developments there have stalled, despite the best efforts of the mathematics specialists and the support of teachers in the sector.

I have a firm belief that we also actually disenfranchise many learners who do not have an A in GCSE mathematics for similar reasons. Either we do not encourage and support them to take A Level mathematics, possibly by adapting our teaching, or we do not offer appropriate pathways. Of course, we need to get the curriculum and teaching and learning right pre-16, but we need to do the same post-16 too.

I used to run networks for heads of mathematics in FE. Through these I began working on a project with Shell Centre at Nottingham, funded by the (then) Learning and Skills Development Agency, to promote greater discussion in mathematics teaching, and focusing on GCSE resit students. The evidence at the time was that in more than 70% of FE classrooms, the teachers spoke and the learners listened (or didn’t!). Following a lesson on solving equations which started by most of the class saying they did not understand any algebra, a group of such students said they did not want to leave until they had solved an equation which at the start of the lesson they had dismissed as impossible. We said they could stay if they would let us film, and the change both in their confidence and tenacity was very evident. The language they adopted when describing the equations also suggested that they were gaining a stronger understanding of how equations were formed and thus how they might be solved.*

The whole process of exploring how we help teachers to try out, reflect on and evaluate new ideas really brought home for me that if we can keep learning for ourselves in a structured way, then perhaps we are much more able to structure the learning for our students.

“Learning Mathematics through Discussion and Reflection” (the LSDA

* A video extract from this extra session is available as part of the presentation of this talk on www.bcme7.org. It is from ‘Learning Mathematics Through Discussion and Reflection’ LSDA (2002). Note that all those in the video are students.
project) formed the basis of the model behind the subsequent DfES Standards Unit framework “Improving Learning in Mathematics”. In working on this, the issue for me then was, and remains, “are we actually enabling learners to learn mathematics?”, which naturally begs the question “how do we do this?”. Isn’t this essentially what being mathematically functional really means?

I mentioned earlier the influence student responses to mathematics can have on our thinking. There are many studies on student perception. In [12], Ofsted noted that “… most pupils recognised the difference between just getting answers right and understanding the work. Nevertheless, many of those observed were content to have the right answers in their books when they did not know how to arrive at them. This view that mathematics is about having correct written answers rather than about being able to do the work independently, or understand the method, is holding back pupils’ progress.” Furthermore, “Many pupils, especially in secondary schools, described a lack of variety, which they found dull. Typically, their lessons concentrated on the acquisition of skills, solution of routine exercises and preparation for tests and examinations. ‘Every lesson, you have to answer questions from the textbook. It gets boring.’” [12]

So are we actually leaving many learners with this view?*

"Algebra class will be important to you later in life because there’s going to be a test six weeks from now."

Ofsted noted a plaintive call for more variety as students “contrasted this with occasional lessons they enjoyed where they did investigations, tackled puzzles, sometimes working in groups, and used ICT independently. Often such lessons happened at the end of term and were regarded as end-of-term activities rather than being ‘real maths’.” These views are in

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*Permission has been granted by Randy Glasbergen only to use this cartoon in this article. It may not be used elsewhere without further agreement obtained via www.glasbergen.com
contrast to those held by the learners from the algebra project mentioned above in this extract, who talk about their involvement in the mathematics they are learning and how the ways of working engage them.*

I have not mentioned the word ‘struggle’. How can we learn mathematics without struggling? And without getting it wrong? I would be delighted if my learners took a view like this: ‘...Mathematics teaches you a valuable way of thinking – you know, the skills you learn ‘at the back of your head’ which apply to any situation that needs some hard thinking.’ [11]

We are sometimes our own worst enemies in mathematics. We spend so much time arguing over things like the semantics of ‘numerosity’ and ‘mathematics’ or in finding things to disagree about that we sometimes lose sight of what we actually would like to achieve. Worse, it means that decisions about mathematics are sometimes taken by non-specialists and built on their own experiences or the evidence of other non-specialists. I think we can all point to examples of initiatives that have suffered in this way. But we can also point to things that we know work and which we should be united in supporting: subject associations, Free Standing Mathematics Qualifications, the Further Mathematics Support Programme and, if you will allow me to add it, the NCETM. Perhaps these are early days, but the Centre runs true to all the above principles and is now engaging well over 41,000 people.

So, in summary: Mathematics is important not only because it is life-enhancing in many practical and creative ways. Therefore we need to build greater mathematical confidence.

In order for learners to understand the important of mathematics and gain such confidence, they need to learn in ways which enable them to do mathematics, struggle with mathematics, understand where it is going, and develop as independent learners of mathematics.

Which means we need a teaching workforce confident and excited about mathematics for its own sake, understanding where the subject can or might go, reflecting on and evaluating their teaching, undertaking enquiry and belonging to communities.

And so they need career-long professional development which requires a professional framework that takes account of, and requires, professional development; opportunities to belong to a number of communities of practice (subject associations are key here); to have a strong understanding of where mathematics can take you; to be able to access and use research; to work in an environment where teaching and learning are the focus and to be involved at the outset in new initiatives.

As Dylan Wiliam’s research suggests, the most cost-effective and time-effective way to improve our education is to support the improvement of our teaching staff. Investment in professional development for teachers would cost considerably less than investment in many of the initiatives that they have to implement.

* A short recording of some of the learners who took part in the project is available as part of the presentation of this talk on www.bcme7.org. It is from ‘Learning Mathematics Through Discussion and Reflection’ LSDA (2002).
And the progression towards achieving this requires us as a mathematics community to find common ground and work closely together so that teachers can benefit from all that we can offer, and policy makers hear from a united community, rather than a fragmented one.*

References
11. *Factors influencing progression to A Level Mathematics* (NCETM 2008)

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The answers to the *Nemo* page on compasses from July were:

1. John Milton Paradise Lost, Book VII
2. John Donne A Valediction forbidding Mourning
3. Edgar Allan Poe The Gold Bug
4. Jonathan Swift On a Circle
5. Robert Frost Moon Compasses
6. Edmund Waller Long and Short Life

Congratulations to Bruce Roth for identifying all these quotations. This month we extend our sympathies to those who find mathematics difficult or impossible. The quotations (see page 411) are to be identified by reference to author and work. Solutions are invited to the Editor by 31st January 2011.

* The talk ended with a view from learners who have had a rich experience of mathematics. The video extract is available as part of the presentation of this talk on www.bcme7.org. It is from [13].