

How can we get more (good) teachers of mathematics - in our primary schools, secondary schools and F.E. colleges?

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One way to get more teachers of mathematics in schools and colleges is to 're-train' the teachers we already have. Re-training teachers, of other subjects and from other phases, to teach mathematics has been happening in the UK for some years. Originally known as Post Initial Teacher Training (Post-ITT) Subject Knowledge Enhancement (SKE), the programme has recently been renamed Teacher Subject Specialism Training (TSST). The UK government has pledged £67 million for new programmes to train up to 17,500 teachers of mathematics and physics over the next Parliament. With the reformed GCSE and the expectation that most post-16 students will engage with some mathematics – retaking GCSE, studying for a Core Maths qualification as well as A and AS levels, many more mathematics teachers will certainly be needed. How viable is TSST? My research centres on case studies from the 2014 cohort of students with a view to tracking them for four years. The Post-ITT SKE course combined 100 hours each of face-to-face tuition and e-learning provision. Participants are from primary, secondary and F.E. I focus on one case study: a science teacher who is now Head of Mathematics; she claims the course has changed her life.

Keywords: Post Initial Teacher Training (Post-ITT) Skills and Knowledge Enhancement (SKE) Maths programme; Teacher Subject Specialism Training (TSST); Core Maths

Background

One of the key problems to be solved in the mathematics education in this country is that the demand for Mathematics teachers is far in excess of the supply. Over the past 3 years, Post-ITT Subject Knowledge Enhancement courses have helped increase the number of teachers of mathematics. The Centre for Innovation in Mathematics Teaching (CIMT) at Plymouth University has been teaching Mathematics Post-ITT SKE courses in a variety of locations, based on e-learning for subject knowledge and face-to-face meetings for reinforcement and enhancing pedagogy with the aims:

- enhance participants' mathematical knowledge to give confidence to teach up to and including Higher Level GCSE Mathematics;
- inspire and enthuse teachers;
- provide motivating introductory activities, tasks and presentations for teaching mathematics.

As a course tutor for two of these locations, the research has centred around seven Case Studies from the 2014 cohort of participants. The participants were 'retrained'^{2*} over a period of one year, participating in teaching and learning opportunities

² 'Retraining' is the best fit word for describing the intended outcome of this course, and is not intended to imply that the teachers are not already fully trained and qualified.

involving: active participation; group work; collaborative lesson planning; problem solving activities; interactive sessions; reflective journals; research input; and resources evaluation. The interweaving of pedagogy and mathematical content was integral to this course.

This study will take account of this shortage of effective maths teachers, and so we need to acknowledge this shortage and have an agreed ‘understanding’ of what is ‘effective maths teaching’. The ACME report, *Initial teacher education of teachers of mathematics at primary and secondary: have your say* (2014, p. 2) outlines this shortage and identifies a growing demand for maths teacher: for the growing school age population; for the extra demands from the reformed GCSE; and for the new post-16 Core Maths qualification. The recent report by Coe, Aloisi, Higgins, & Major, (2014) for the Sutton Trust, explores ‘What makes great teaching?’ and acknowledges that defining ‘effective teaching’ is no easy task. The definition settled upon in their report: “We define effective teaching as that which leads to improved student achievement using outcomes that matter to their future success” (2014, p2). This then leads to further questions which are beyond the scope of this report: What outcomes matter and what do we mean by ‘future success’?

The McKinsey report (2007), based on effective educational systems from around the world, makes it clear that subject knowledge is important but that teachers also need to observe and reflect and identify what makes for great instruction in their subject and then have in place support in schools to ensure that teachers can deliver great instruction lesson after lesson; that is, provide an environment that sustains great instruction.

Method

To conduct this research, I am following several case studies over a period of 4 years. This longitudinal study involves: interviews; questionnaires; participant personal reflection notes; lesson observations; and field notes.

The approach will be to use general inductive analysis (Thomas, 2003): allowing findings to emerge from the data whilst simultaneously being guided by my research objectives. Those objectives being to consider:

- Can the Post ITT SKE courses, that I deliver, affect change in teachers’ practices?
- If so what are the changes, and will any take root?
- What factors affect whether changes are embedded in practice?

Case Study: ‘Bee’

“...This course has genuinely changed my life.” Bee

Bee started teaching in 1989 in London and has taught in a further two co-educational state comprehensive schools. Since 2004, Bee has been an Assistant Headteacher (AH); prior to this she was a Head of Science. In her role as an AH, Bee continued to teach Science and line manage several departments including Maths. In 2013 the school failed to find a Head of Maths or indeed a maths teacher at all. However, there was, according to Bee “an embarrassment of riches” in the Science department. So the decision was made to merge the Maths and Science departments: five science teachers ‘volunteered’ to each teach one maths group each, thereby negating the need to recruit a maths teacher. Two of these Science teachers attended the Post ITT SKE course; a third came to the Introductory Meeting and was disappointed - due to time constraints

- to be unable to continue. From the questionnaires and interviews it is clear that key factors driving Bee to attend this course were: to be able to address children's misconceptions in maths, link mathematical topics and boost pupil confidence. Bee believes the course addressed these needs and now feels able to teach maths as she would science: deliberately putting misconceptions in pupils way to provoke thinking.

I have observed Bee teach the same Year 11 class (grade D/E students) twice this academic year and listened to her talk to her pupils about their maths lessons. From one of my lesson observation reports I had noted the following:

Strengths:

- Immediately on arriving in the classroom, the pupils appeared relaxed and at ease. It felt that there was a relaxed but purposeful atmosphere amongst pupils.
- The strong pupil-teacher relationship was clearly apparent.
- A definite sense of the pupils needing to think. It was demanded and expected from them (I observed, and wrote in my notes: independence of mind).
- The starter was chosen deliberately to provoke pupils to think.
- It felt like the pupils were doing higher level maths than the actual set questions required. Questions were raised (e.g. 9 divided by 0) and discussed. Pupils were clearly mentally provoked by these queries. Mathematical language was used throughout, references to quadratic graphs made.

Towards the end of one lesson Bee asked her pupils some questions about what they thought and felt, regarding maths. When asked if they have to think in maths they all responded emphatically and almost in unison, that yes they have to think a lot, more than in other subjects and more than in previous years for maths. And that "Yes!" this a good thing. Other pupil comments were noted and included:

- There are harder questions ... [previously in maths] it was too easy
- More challenging work this year
- Can ask each other when get stuck
- We feel like you [the teacher] respects us and we respect her.
- We are mentally engaged'
- It depends on your teacher. Didn't get on with the teacher last year - so we just mucked about
- There is no negativity - we don't feel judged...
- Somebody might get something wrong but nobody laughs [like would have happened last year]
- We don't use text books [and this is seen as a good thing]...not being told to get textbooks out and turn to page...It is as if the teacher doesn't really care then
- She [the teacher] knows what she is talking about
- You [the teacher] mix it up... you remember much more ...
- You move round the class talking to and helping us all

The general consensus from the pupils was that they don't feel like they are in a 'set' or 'setted'. It feels different. (They have been 'handpicked' from various previous sets to form a new group. Handpicked by Bee because they were "spectacularly bombing out from their predicted grades, and /or where previous relationships with teachers had broken down.")

Having observed Bee several times, and twice with this group, and from interviews and other conversations - I know Bee is keen to promote cognitive autonomy. This is clear from several of her comments and her own personal research surrounding autonomy.

...we have to teach in a way that allows for mastery and fluency. And then incorporate the self determination theory that should generate intrinsically motivated learners...If we get the former right [what we teach and how we teach it], pupil behaviour will improve.

To summarise from my own observations: The pupils believe in her and believe she knows her 'stuff'. Pupils are engaged and behaviour is exemplary. The work is more challenging and pupils feel safe; safe to try things, safe to get things wrong without ridicule. Bee 'gives' of herself by telling little 'stories'; by so doing Bee models how to be open to posing questions, thinking about them and enjoying the process. And there is a shared sense of purpose - for all to achieve well at the end of the year. This (plus much more) all adds up to the vibe you would like to bottle for a grade D/E type class.

The merge of departments was, according to Bee, a good plan and a good vision but it ran for only the 2013-2014 year. According to Bee: "It was a spectacular failure." When asked why, Bee listed the following reasons:

- a personal toll on the Head of Science, trying to run two departments
- The Science department suffered as lack of attention as the Head of Science focussed on the less familiar Maths issues
- The Maths department didn't develop, it simply stagnated. And the Maths department could not 'afford' for this to be the case.

For the 2014-2015 year, having failed again to appoint a Head of Maths (HOM), Bee suggested she took on the role in addition to being an AH. Bee: "I don't want to be HOM but I don't **not** want to be HOM; I want to be in charge of what we teach and how we teach it, but not the day-to-day management." Bee credits the course for her new found confidence in her own beliefs - and she is now in the process of transforming the Maths department. Bee believes it is the Post ITT SKE course which gave her the confidence to take on the role of Head of Maths and determinedly reshape the department.

I do have to also add that participating in this course has been a transformation thing for me; and my school...Since taking the course I have absorbed the job of head of maths, line managing it had just left me so disappointed by the quality of candidates... I am determined to eliminate the linear-ness, silo-ness, textbook teaching all has to go; None of that would have happened without this course...**This course has genuinely changed my life.** God how x-factor. I would never have had the confidence to take on my Maths department and challenge them to understand that they (the qualified ones) are wrong and I (the physicist) am right if I hadn't had opportunities to chat with all of you and to learn alongside you.

In November 2014 the school was inspected by Ofsted: All the teaching in Maths was good or better. Two outstanding lessons were seen in the course of the inspection - both were Maths lessons (Bee was one of these teachers).

Discussion

So - although early days - it does appear that this Post-ITT SKE course has had significant impact for this one Case Study.

Bee, when asked if she feels she could have taught maths this way without the SKE course, said “yes - but [now] with added confidence and knowledge surrounding common misconceptions. BUT now [I have] the confidence to transform the whole department in this SKE image.” There seems no doubt that Bee has felt confident to make major changes to the department as a direct consequence of the SKE provision.

So why is it working for Bee? And can it do so for everyone?

Bee has embraced the SKE ethos of promoting deep thinking and understanding. Developing confident, competent mathematical thinkers is seen as integral to the department’s aims. Problem solving is to be a principle teaching strategy. This is perhaps possible because Bee is a key player in the school. She is hugely influential, charismatic and well respected. As a senior teacher, Bee can make these decisions and then also have the time and space to reflect upon them and encourage others to adopt similar strategies. Bee appears aware of the big picture and the purpose: She can combine pedagogical skill and mathematical wherewithal. As an Assistant Head, Bee is a reflective practitioner striving to improve her own maths teaching practise. It will be interesting to see if her department will now follow suit. Another Case Study of mine is within this department so I will be able to view two different perspectives over a significant period of time.

All my participants have commented on how enriching the Post ITT SKE course has been to their own lives. The question is: Can this enrichment translate to the pupils’ experience of maths lessons? Implementation of the ethos is going to be a key factor in determining this. Where I have seen less successful practice amongst SKE participants, lack of time and lack of support from senior teachers are the two most frequently cited comments. In Bee’s case she *is* a senior teacher and she *does* have time. Embedding the SKE ethos through Lesson Study could be a key implementation strategy.

A final observation of possible note: The only two Science teachers still to be teaching maths in Bee’s department are the two who completed the Post ITT SKE course.

Summary

By following Bee and other Case Studies, we have the chance to see if one of the Government’s current strategies to improve mathematics instruction can ever provide a sustainable way of helping the nation to improve its mathematical provision at a time when economically competing countries, particularly in the Far East, are making significant improvements in their mathematical standing in the world.

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