Shanghai mathematics exchange - views, plans and discussion

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Two recent mathematics education innovations are the proposal for English mathematics teachers to learn from their Shanghai counterparts and the creation of Maths Hubs (which will organise England-Shanghai exchanges). This session provided three perspectives on the Shanghai initiative. This report summarises the day conference presentations. Our aim in doing this is to encourage constructive and respectful dialogue on government initiatives.

Keywords: Shanghai; Maths Hubs; classroom teaching; mastery teaching

Introduction

Two recent mathematics education innovations are the proposal for English mathematics teachers to learn from their Shanghai counterparts and the creation of Maths Hubs (which will organise England-Shanghai exchanges). These are important initiatives and we feel there is a need for discussion where different voices (from the classroom, from the Maths Hubs, from academia) can be heard. This was John's view when he invited Fiona, Jeremy and Tony to join him in a BSRLM presentation and discussion of the 'Shanghai exchanges' which are taking place in 2014 and 2015. This paper presents the voices of three participants. Fiona teaches secondary mathematics in a school near to York but she was born, raised and schooled in Shanghai. Fiona is in a unique position to present an English audience with a feel for Shanghai mathematics from a past learner's perspective. Tony teaches mathematics in a secondary school in Halifax which has become a Maths Hub (and Tony is the leader of this Hub). Tony views this exchange as an opportunity for teacher professional development to improve student engagement with mathematics in classrooms. Jeremy is an academic whose specialisms include international comparative studies in mathematics education.

Fiona's perspective: an insider's view of school mathematics in Shanghai

The Chinese National University Entrance Examinations are very different from the A-level examinations in the UK. In Chinese, they are called 'Gaokao'. They start on June 7th every year nationwide and last three days. Every mark in the examinations is important, as there are no 'grades' in China. These examinations are not designed to recognise what students have achieved; the function of Gaokao is to select the best students. No personal statement, no reference, no predicted grades, merely the examination results determine which university you enter, where you live, and to a large extent, how much you earn in the future. For students in rural China, Gaokao is a life-changing opportunity. For students in Shanghai, even though the entrance rate is much higher than the national average, Gaokao is still the only official way to assess 12 years of study. In a megacity with a 24 million population, a degree certificate is a basic starting point to most office jobs.

Throughout 12 years of schooling, the curriculum, syllabus and examination board is exactly the same across Shanghai. Students are grouped into 'classes' which are fixed for every subject, and there are about 40 students in each class. Setting is not officially allowed, even though some schools set one or two classes as 'experimental classes' to give the top fliers some enrichment activities.

Mathematics is compulsory for everybody before university. To ensure fair play, the Shanghai Educational Bureau issues one Mathematics textbook per term to all students in Shanghai. Each lesson starts with definition of a mathematical concept, followed by examples and exercises. Accuracy and consistency override any attempt to make mathematics relevant. Topics are taught in a certain sequence. The linear curriculum reflects the idea that "new mathematics concepts build upon the old ones". The whole school curriculum is a very 'pure' approach, where mechanics is taught in physics and statistics is just lightly touched.

The textbook was all that I needed in primary school for mathematics. In junior middle school, apart from using the textbook, everybody in my school bought a homework book as a top-up. The textbook in senior middle school started to be detached from assessments. Examples and exercises are too simple to prepare students for tests and exams. The quality of textbooks seems to be the other way round in the UK. When I started teaching in the UK, I was shocked to see the mistakes in KS3 textbooks (almost every book I have used had mistakes in them, but the KS3 materials seem to be particularly bad). In the UK, schools choose their examination boards and textbooks; the department decides their own teaching orders; the teachers choose their own teaching materials. I often search on TES website to get the highly rated 'popular' resources, but there have been many times when I had to inform my students to 'look for mistakes' in these materials. In my opinion, there is not much point having a huge variety of teaching materials with mistakes and inconsistency everywhere rather than having one faultless and consistent version.

In Shanghai, schools, teachers, and students are free to choose any study guides. If you walk into any book shop in Shanghai, study guides often occupy a huge section. In my school, the teachers chose a work book for every student (*yi ke yi lian* published by East Normal University). 'Yi ke yi lian' literally means 'one lesson one exercise'. There is one A4 page of mathematics questions after each lesson. It matches each textbook exactly and most homework was from this book. The starting exercises check the basic understanding and skills, while the last one or two questions usually can only be solved by very few students. When I did my teacher training in the UK, I struggled to give a grade to the topic I was teaching. I tried to argue that we should not 'grade' or 'level' questions according to the 'topic'. The levelling of a topic depends on how the teacher teaches it, and how the students respond to it.

In Shanghai, as soon as the basic ideas are introduced, students are exposed to all sorts of non-routine tasks. The non-routine tasks are usually a shock to most students initially but they soon become routine questions after the teacher or students explain their solutions. There are always more challenging problems to follow, without a label of grade or level. Such claims as "the teacher hasn't taught me how to do this kind of problem" never stands, as mathematics problems are for you to figure out. "If you can't do it, you are not bright enough, or you haven't worked hard enough". From a teacher's point of view, mathematics problems are often too easy or too hard for students. It is very difficult to find the 'right tasks'. Good tasks and interesting tasks take a lot of time and effort. I was wondering if it is possible to share the 'problem banks' between Shanghai and the UK. Also, it is important to help teachers find these good tasks more efficiently.

A full-time mathematics teacher has only 12 lessons a week. However, they do have a lot of subject-related duties, such as supervising students in form time, lunch break, and after-school exercises sessions (arranged by individual schools), but the workload seems nowhere near that to be found in the UK. Apart from planning lessons and marking students' work, they also have 'subject research activities'. In Shanghai, every teacher only deals with one year group – usually two parallel classes in the same year. They know every chapter of the textbook inside out. Through these research activities, they discuss 'what is the most effective way to explain a particular concept from different perspectives for different students'. They plan lessons together, and they are also trained to deal with huge class sizes by targeting individual students.

Tony's perspective: From a Maths Hub

In 2014 the DFE announced the setting up of 34 mathematics hubs (Maths Hubs) across England. The hubs are designed to be regional centres for collaborative, school led development and improvement of mathematics teaching and learning. The hubs will lead and facilitate regional projects as well as develop local and regional partnerships. The aims of the hubs are very clear. Essentially there is to be resolute focus on pupils' mathematics outcomes, namely

- improved levels of achievement
- increased levels of participation
- improved attitudes to learning
- closing the gaps between groups

The hubs aim to provide determined support for teaching, leadership and curriculum in mathematics. The aim is to be collaborative. Each hub works with around 500 schools across a specified district, although schools can work with any hub in England, depending on what they are offering. It is difficult for hubs to provide individual support for schools and they have to use existing alliances and partnership. At the centre of the hub is the lead school and their strategic partners, who have a track record of excellence in mathematics. They then work with teaching schools and other schools to try and support the needs of the schools in the local areas. Each of the hubs has established a series of Work Groups that focus on a particular need identified. The White Rose Mathematics Hub is focusing on mastery methods, mind-sets in teaching as well as increasing post-16 participation.

There are three national collaborative projects.

1) Mastery pedagogy for primary mathematics 2 – Use of high quality textbooks (linked to Singapore) to support teacher professional development and deep conceptual and procedural knowledge for pupils. This project will focus on trialling and evaluating the use of textbooks to support Mastery teaching in Year 1, with the intention that this is followed through to Year 2 next year.
2) Post-16 participation – Intensive project with priority schools and colleges working with Further Mathematics Support Programme and Core Maths Support Programme This project will focus on increasing participation in level 3 mathematics and will involve each Maths Hub working intensively with a targeted group of schools and colleges.
3) The third project is the England –China project. In October 2014, two teachers from each of the hubs visited primary schools in Shanghai. The aim was to see what they might be able to learn from practice out there. Although there were some significant culture differences between England

and Shanghai colleagues brought back many ideas that they were really excited to trial in classrooms in their own school.

Some of the ideas trialled at the moment include:

- A greater focus on number and the basics of mathematics, including moving shape and other areas to topic work on the afternoon.
- A focus on teaching for understanding, building deep conceptual and procedural knowledge for students.
- Spending a greater length of time on these topics.
- More formal approaches in the classroom, sitting students in pairs as opposed to groups on tables.
- Providing teachers with time during the day to provide immediate feedback to students and intervention.
- Developing a model of using subject specialists.

The work of the Maths Hubs continues and all those involved are excited by the difference that collaborative school led practice might be able to achieve.

Jeremy's perspective: Learning from international comparisons

I want to begin by welcoming the Shanghai Mathematics Teacher Exchange Initiative. There are many ways in which we can learn from the Shanghai teachers and their approaches to teaching, and I believe that any initiative that encourages teachers to look internationally is of tremendous value. I have met several of the Shanghai teachers and found them to be thoughtful and interesting teachers, who are as keen to learn about the English system as they are to show the approaches that they use in Shanghai.

However, I do want to sound some notes of caution. First and foremost, I think it is important to value the strengths and successes of mathematics education in England. Certainly, there are things that could be improved and I myself have pointed to how some key mathematical understandings have fallen since the 1970s (Hodgen, Brown, Küchemann & Coe, 2011). However, whilst I am of the view that mathematics education in England needs improvement, I also firmly believe that our system is not "broken".

For the past 20 years or so, politicians of both main parties have regularly highlighted how England (or the UK) performs poorly in relation to other systems. When announcing the 2011 review of the National Curriculum in England, Michael Gove, then Secretary of State for Education, argued that the (then) latest international survey results from the OECD's Programme for International Student Assessment (PISA) survey showed that "we haven't been progressing relative to our competitors; we've been retreating. In the last ten years we have plummeted in the rankings: from … 8th to 28th for maths".[1] In fact, England's relative performance is better than Gove suggests. Looking at the Trends in International Mathematics and Science Study (TIMSS), the rise in performance between 1995 and 2011 at primary (Year 5) is the largest achieved by any educational system at either primary or secondary and England's performance in mathematics at primary is now well above average and is ranked 9th internationally (Mullis, Martin, Foy & Arora, 2012).

Moreover, on both the TIMSS and PISA surveys, there are aspects of mathematics, such as statistics or data-handling, where English students appear to do well in comparison to other countries. In the past at least, English students have been particularly successful at problem-solving. Indeed, many of the high-performing Pacific Rim countries have looked to England for ways of developing creativity and

problem-solving. So, for example, Lin's (1988) replication of the Concepts in Secondary Mathematics and Science (CSMS) study (Hart, 1981) in Taiwan showed that, although the Taiwanese students out-performed English students, they were less willing to invent and use informal strategies when tackling ratio problems. As a result, the Taiwanese students were less prepared for more unusual and non-routine problems.

About five years ago, we (Mike Askew, I and others) reviewed the research evidence relating to how high-performing countries performed so well on PISA and TIMSS (Askew, Hodgen, Hossain & Bretscher, 2010). In doing so, we highlighted the dangers of "cherry-picking" policies from other systems. Educational systems are complex and, out of context, policies that 'appear' to work in one system may have adverse effects in another system. For example, in a re-analysis of PISA 2003 data, Guzel & Berberoglu (2005) found greater technology use to be associated with higher performance in Brazil, lower performance in the US and not at all associated with performance in Norway.

We also pointed to the importance of educational values (Askew et al., 2010). It is difficult, for example, to imagine a school with the motto of one school in Hong Kong: "Holistic Education – To Learn, To Earn." I don't want to suggest that this school's motto is somehow 'wrong' or misguided, but rather that the achievement of the Pacific Rim countries is likely to be the result of many cultural factors. Indeed, Usiskin (2012) argues that a key factor in Singapore's performance is the way in which 'school' is seen as children's 'job' and the ensuing expectations that go with this.

We did suggest that school mathematics textbooks were significantly better than the textbooks that are widely used in England (Askew et al., 2010; see also, Hodgen, Küchemann & Brown, 2010). Textbooks in the Pacific Rim tend to have a wider and more varied range of examples, better and more mathematical explanations and give better pedagogic guidance to the teacher. The government's initiative, Mastery Pedagogy for Primary Mathematics, to investigate whether the two best-selling primary textbooks from Singapore are effective in English schools is an important one. It is worth remembering, however, that these textbooks are not uniquely Singaporean and many of their features are 'borrowed' from England and elsewhere. For example, Fong Ho Kheong, the principal author of one of these textbook series, *My Pals are Here Mathematics*[2], learnt his craft in England studying for a PhD with David Johnson at King's College London. Indeed, the celebrated Singaporean 'model method' is perhaps best seen as an amalgam and development of English, Dutch and Russian approaches to representation.[3] This experience highlights a further important feature of Shanghai and other systems – the extent of collaboration between educational researchers in universities and teachers in schools. The 'Normal', or pedagogical, universities in China have been immensely important in the development of strong and effective pedagogy and in training strong knowledgeable teachers, as has the National Institute of Education in Singapore. One lesson from the teacher exchange initiative might be that in England we need to ensure that we maintain a strong, vibrant and well-funded university (teacher) education sector.

Finally, there is much to be gained from international comparative work and collaborating with teachers and others from other educational systems. This provides a valuable mirror to reflect on our own practices and to learn from strengths elsewhere. We should not forget that systems, like Shanghai, Singapore, Hong Kong and Taiwan, have all looked to English mathematics education research and practice in reforming their systems.

Conclusion

In this report, we have presented three perspectives on the Shanghai teacher exchange. We look forward to further constructive discussions as the initiative develops.

Notes

1. Gove was referring to the results of PISA 2009 (OECD, 2010). In fact, England's PISA results are at the OECD average and perhaps best seen as stable over time (Jerrim, 2013).
2. See: http://www.straitstimes.com/news/singapore/education/story/singapore-maths-travelling-the-world-20141023
3. See Ng & Lee (2009) for a discussion of the development of the model method.

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