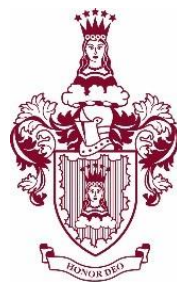


Preventing rather than closing the gap in Mathematics

Andrew Smith

WINSTON
CHURCHILL
MEMORIAL
TRUST



THE
MERCERS'
COMPANY

Copyright © 07/01/2018 by Andrew Smith. The moral right of the author has been asserted.

The views and opinions expressed in this report and its content are those of the author and not of the Winston Churchill Memorial Trust, which has no responsibility or liability for any part of the report.

List of contents

Acknowledgements	4
About me	5
Introduction	6
Methodology	8
Travel Summary	9
Findings	14
Conclusions	28
References	29

Acknowledgements

I would like to thank the Winston Churchill Memorial Trust, Mercers' Company and Winton Philanthropies for enabling me to expand my professional career beyond the classroom and engage with individuals and organisations that have inspired me to develop my practice and share my knowledge with others.

A huge thankyou to Suzen Tseng at the Taipei Representative Office in the UK, Randy Leung at the Education Bureau at the Kowloon Government Offices in Hong Kong and Jessica Wan at Jinhui Elementary School in Chengdu, China, for their support in organising such wonderful school and university visits and for their patience in supporting me learning about their education systems.

Thank you to all the teachers who allowed me to watch their lessons, the principals who allowed me to visit their schools and speak to their teams and the universities and education departments for their support and time introducing their approaches to me and answering my questions. It was invaluable and appreciated and I hope to return the favour one day.

About Me

I started this research whilst working as a Maths Coordinator at a community primary school in West London and am currently Deputy Head at Shaftesbury Park Primary School, a bilingual community school in Wandsworth.

My background consists of 12 years in primary education, including 7 years in international and local schools in China and Singapore. I developed my understanding of bilingual education when I took a sabbatical to study Mandarin at Beijing Normal University and then worked in a bilingual local school in Shanghai – YK Pao Primary School. At this school I had the opportunity to work with the mathematics department and took part in lesson studies, lesson observations and meetings.

I am currently an outer-circle member of ACME – the Advisory Committee for Mathematics Education and follow with fascination the current interest in Asian mathematics. I am particularly interested in ensuring a balanced approach to implementing Asian style mathematics teaching in the UK and support local schools implementing a mastery approach.

Introduction

In the 2015 Programme for International Study (PISA), a worldwide study by the Organisation for Economic Co-operation and Development (OECD, 2013) of 15-year-old scholastic performance on mathematics, science and reading, the top 7 countries were all East and South-East Asian. Unfortunately, the UK had, 'dropped from eighth to twenty-sixth place in international tests of problem solving.' (Boaler, 2015) These results sparked a re-evaluation of the educational strategies in the teaching of mathematics used within the UK and stimulated the study of the approaches used in Asia through a variety of government led initiatives.

The successful performance of Asian countries is due to a complex balance of pedagogy, curriculum and culture, yet there has been a tendency to focus upon the measurable aspects of the Asian approach which can be easily replicated or transferred to the UK. One such approach is memorisation which was initially reported as a successful Asian strategy even though the PISA study shows that, 'there are no high performing countries in the world with high proportions of students who use memorisation as their main strategy.' (Boaler, 2015)

The purpose of this research was to investigate the role of non-classroom based factors such as homework and parental engagement in mathematics education in Asia. During the research process it was expanded to include intervention strategies. This focus was developed in response to the 'Report on International Maths Research Programme,' (NCSL, 2014) which was a Department of Education funded study where a group of 48 schools exchanged teachers between Shanghai and the UK and has provided the foundation for much of our current understanding of East Asian mathematics. The reports into this project have been incredibly detailed and include complex analysis of the different approaches used in Shanghai as well as the cultural background of education in China. They have been impactful in identifying the necessity of a structured curriculum as well as a mastery approach, yet their reference to the role of homework and interventions is brief and requires further research.

When I worked in a school in Shanghai I realised that there is more to mathematics education in Asia than just the taught mathematics lessons, lesson studies and structured curriculum. The role of the family and class teacher extending and developing the learning outside the classroom was a crucial part of the child's education. Teachers would dedicate their lunchtimes to extra tuition and spend their evenings supporting parents with homework. Parents and grandparents would spend hours each night supporting homework and taking their children to tutors. Whilst the report referenced that, 'teachers are responsible for no more than two or three lessons per day. The rest of their time is used to plan, mark and tutor children who have struggled in a lesson,' (NCSL, 2014) it does not refer to what this will involve and certainly does not highlight the level of extra work required by class teachers to support children outside of lessons.

As a fluent Mandarin speaker, I am in a unique position as I can engage directly with my colleagues in Asia and not rely upon the process of translation. Lotman's theory states that "no language can exist unless it is steeped in the context of culture; and no culture can exist

which does not have at its centre, the structure of natural language" (Lotman, 1978). To accurately translate a maths lesson between English and Chinese requires a strong understanding of the history and current usage of the terms used in both languages, also an awareness of the cultural usage of the terms. The challenge of this is demonstrated by the recent push for 'technical terms' to be used in UK classrooms as a result of observations of Chinese lessons. (NCSL, 2014) Many UK researchers were impressed by the technical clarity of expression used in Shanghai lessons and have repeated the same approach in the UK. However, there is a lack of complexity in Chinese mathematical terms compared to English terms – which largely originate from Greek, Latin and Arabic origins whereas the Chinese simplistically describe the concept studied. For example, a word such as 'pentagon' in English originates from the Greek penta- (five) and -gon (angled). The Chinese word is similar in meaning; 五边形 which literally means '5-sided shape.' However, when translated, you would not translate the Chinese word using its literal meaning, '5 sided-shape' but will use the correct, technical English translation, 'pentagon.' Not relying upon translation will allow me a greater depth of understanding, both in terms of understanding the actual language used in class to support conceptual development, and the ease of communication will allow me greater insight into the working lives of mathematics teachers.

During my trip to Taiwan, I visited The Affiliated High School of Kaoshiung University where I was welcomed by the principal and invited to watch two lessons. Both lessons followed a practical investigative learning approach and was based upon correcting students' misconceptions, however they were in no way comparable to the quality of lessons observed in other schools. On closer analysis it appears that the children at this school were mostly university employee children and are supported by their parents at home. This experience reflects the experience of many of the of the UK researchers who visit Asia and are allowed access to only the best schools, a fact which was described as, 'much was striking and inspiring, although there was no exposure to middle or lower ability students or those in vocational schools. Access to schools, however, reflects a growing trust and new partnerships with the region from which system leaders benefited.' (NCSL, 2014) Access to schools in East Asia has largely focused upon high-achieving schools and ignored the diversity of challenges faced by educators in these countries – my language abilities and contacts in the region allowed access to schools that are not normally visited by researchers.

The government has announced increased funding for research into Shanghai mathematics with the aim that, 'Shanghai's top maths teachers will be embedded in primary schools across England ... to share their world-class approach to maths teaching, and help further raise standards in the subject.' (Department of Education, 2017) It is important that we understand the cultural factors as well as the practical implementation of Asian pedagogy before we embed these approaches across the UK.

Methodology

There have been three different stages to researching this paper: research focusing upon the existing academic and policy literature in the UK concerning Asian mathematics which has included semi-structured interviews with researchers and policy makers in the UK who are involved with the Shanghai Teacher Project; lesson observations and discussion with teachers and head teachers in Hong Kong, Taiwan and China and semi-structured interviews with parents in China.

The starting point for my research was the Report on International Maths Research programme China which was published in 2014 and sparked my interest in academic research into Asian mathematics. I have attempted to include a mixture of academic research, articles and government publications to ensure a balanced representation of current opinions towards Asian Mathematics.

Travel Summary

Hong Kong

Hong Kong SAR consistently performs in the top 5 countries in the PISA tests and presents an interesting region to focus on due to the changing and often challenging political, economic and social situation. There are many areas of significant social deprivation with one in seven people in Hong Kong being classified as deprived. Thus, it is an interesting comparison with the UK as educators in Hong Kong face similar challenges such as poverty, falling birth rate and significant immigrant populations.

There are a range of schooling options available to parents in Hong Kong. The schools provided by the Hong Kong Education Department can be divided into three main groups: government schools; subsidised schools, which are usually administered by charitable bodies; and private schools run by different organizations where admission is more often decided by academic merit and whose style and language of instruction appeals to international parents. Immersion courses are provided to recently arrived immigrants from mainland China to help them adapt to Cantonese education in government schools. Primary schools used to be separated into morning and afternoon schools as a method of dealing with the problems of a lack of space and the large student numbers. However, with changing demographics and a falling birth rate, most primary schools have moved to become whole-day schools.

My contact in Hong Kong was Randy Leung, a member of the Kowloon Ministry of Education. I had expressed an interest in visiting schools that were not model schools but taught children from a wide range of social backgrounds. Randy organised for me to visit three schools in different parts of Hong Kong facing different challenges, as well as a discussion session with the mathematics department at the ministry of education.

The final visit in Hong Kong was to the Mathematics Section and the Kowloon Education Bureau. King-Man Leung, the head of the department presented the Hong Kong approach and areas of focus the government are developing and I presented on current UK theory. We also shared resources that have been developed and shared with schools in Hong Kong and the UK. The department creates box sets of resources and activities that are designed to improve different curriculum areas each year and are distributed across Hong Kong. They also publish the textbooks and they are widely available in bookshops.



Hong Kong demonstrated all the qualities of Asian Mathematics as explored in the UK research, such as detailed curriculum design, a curriculum that is improved regularly through lesson study but whose core remains consistent and a text book supported curriculum. However, I was also impressed by the dedication of the teachers who worked through their breaks and lunchtimes to support children not meeting the demands of the lesson and tailored instruction to the needs of their class. Every adult I spoke to discussed the demands of ensuring every child succeed and highlighted the importance of collaboration with the parents to ensure success. The Department of Education produced resources that supported teachers and provided professional development to enhance teaching ability.

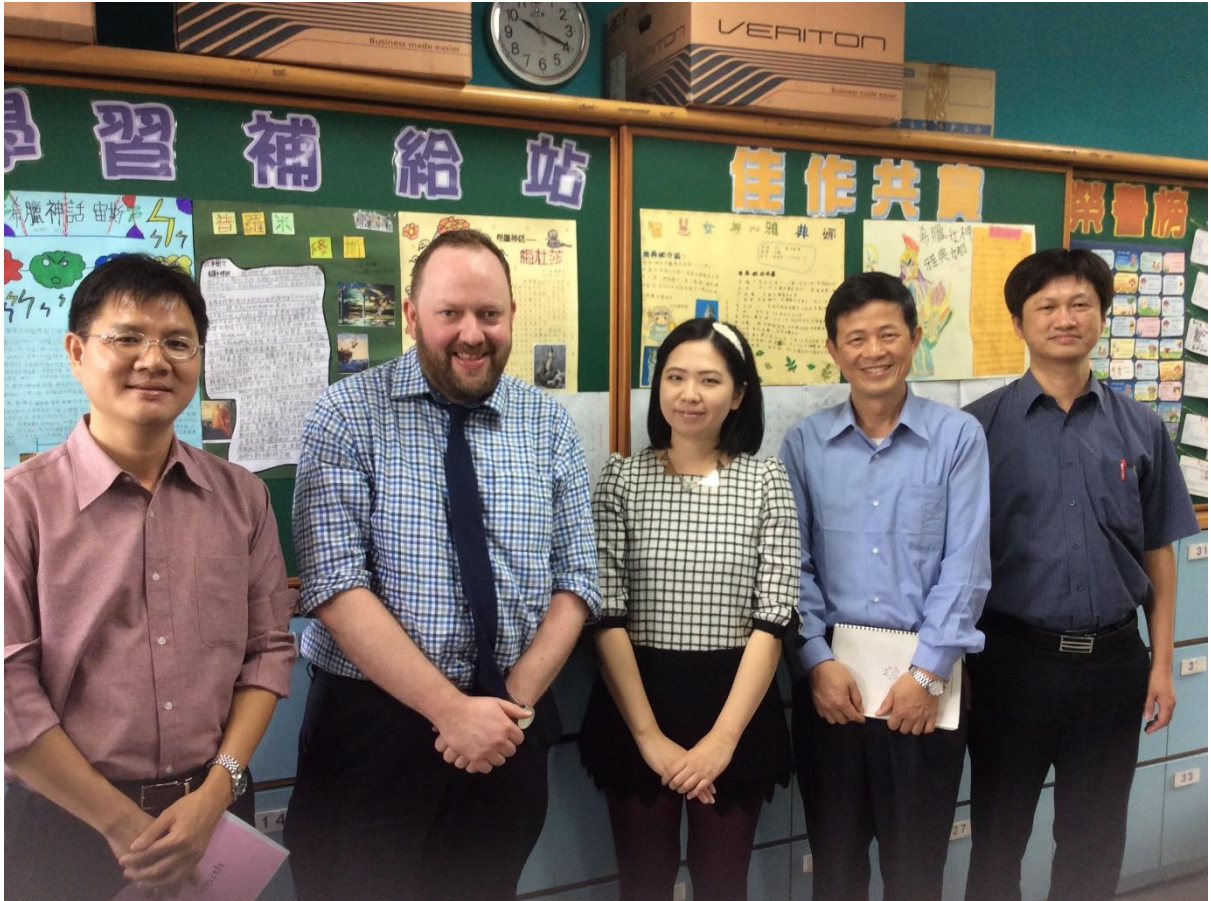
Taiwan

Visiting Taiwan was another opportunity to learn about a country facing a range of political and social challenges yet consistently performs well on PISA. With a diverse population comprising indigenous communities and mainland Chinese heritage and a progressively large expatriate community in cities and centres of technology there is an increasing complexity of societal needs.

My initial contact was Suzen Tseng at the Education Department of the Taiwanese embassy in the UK. She briefed me on the challenges facing Taiwan, including high rates of unemployment for teachers, a shrinking economy that is affecting manufacturing regions and an ageing population yet falling birth-rate. Suzen organised a schedule that would visit a range of areas across Taiwan that would highlight the impact of these issues and provide a different perspective upon Taiwanese education. The focus for my travels changed in Taiwan and looked at the systems at a university and governmental level to support schools and parents.

The first schools I visited were organised by Professor Grant Liu of the National Hsinchu University of Education in Hsinchu, a city in northern Taiwan. Hsinchu is famous for its recent investment in the high-technology industry to compete with Japan, Korea and Singapore. It is also famous for its universities and is currently driving Taiwan's technology sector. Professor Liu provided the most detailed summary of the challenges for education in Taiwan through his discussion of the history of education, particularly the role of ethnic minorities in Taiwan. He explained how Taiwanese society has developed greater tolerance for the ethnic diversity of Taiwan as well as a society that has education as a core value. Due to the current unemployment crisis affecting Taiwan's teachers he described how difficult it is for teachers to enter the profession today, with several years of mentoring, observations and assessment.

I also visited schools and Universities in Kaoshiung, Taichung as well as participating in a lesson study in Taipei. I found that Taiwan is a much more challenging country to study as the quality and type of mathematics varied significantly across schools and regions. What was consistent was the continual involvement of universities in professional development of teachers as well as the development of curriculum and resources.



China

I have already spent 6 years working in China, 2 of which were in a local school where I regularly taught maths lessons in conjunction with a Chinese maths teacher, attended maths department meetings and took part in lesson studies. I decided that my focus would be upon the systems in place to support parents as well as methods of teacher development rather than observing further Maths lessons.

I spent most of my time in Shanghai researching into the different support systems for parents outside of the school which included discussions with local teachers as well as research into the support systems outside of the school – from textbooks in bookstores to after-school study centres.



I was also invited to visit Jinhui Experimental Primary School in the High Technology Zone of Chengdu. This is a school I have visited before and being familiar with the staff enabled me to engage with the school in a different way than on previous visits. I was asked to present a demonstration lesson in front of an audience of 150 visiting teachers. A Chinese teacher also presented their lesson and then our performance was discussed by regional experts. I have been keen to undertake one of these demonstration lessons for a while as there is a negative perception of them in the UK. What impressed me was the tremendous amount of preparation that goes into them – both in terms of the lesson preparation and organisation of the event. The Chinese teacher presented an immaculately structured lesson to a class she was unfamiliar with and demonstrated complete mastery of the subject.

Findings

Role of textbooks

According to Trends in International Mathematics and Science Study (Mullis, 2008), 65% of Grade 4 teachers internationally use a textbook and, 'the proportions of teachers using textbooks as the primary basis for lessons is as follows: Chinese Taipei (94%), Hong Kong (84%), Japan (83%) and Singapore (75%).' In the UK this figure has fallen to 15%.

The rapid changes to the UK curriculum have made it difficult for publishers to maintain up-to-date textbooks, a problem which is not encountered in countries such as Taiwan or China where the curriculum has changed relatively little in 20 years. The value of high-quality textbooks to support teachers in the classroom to deliver quality lessons has become a priority with Nick Gibb recently stating that, 'A key lesson that we have taken from the success of the Far East is the importance of textbooks. We know – thanks to the work of Tim Oates – that top performing jurisdictions have high-quality textbooks that work coherently with the curriculum.' (Gibb, 2017)

The textbooks used across Hong Kong, Taiwan and China share similar features;

- Problem solving questions
- Open-ended investigations
- Detailed child-friendly illustrations
- A character who explains the work and provides background information

During my travels, I observed across all the countries I visited a recognition of the importance of a strong relationship between publishers, university researchers and teacher training departments, the Ministries of Education and teachers. This was emphasised during my visit to National Hsinchu University of Education in Taiwan where we discussed the importance of international cooperation in the development of textbooks and the role of textbooks to support parents. Professor Liu described how the textbook publishing companies provide textbooks at reduced rates to school in return for endorsement. Parents can then buy the textbooks used in class or the additional study guides to independently support their children at home. The publishers were aware that if they were endorsed by a university or school it would increase sales and thus engaged with researchers and study groups. Universities and Departments of Educations used the publishers to promote new approaches or develop creative additional support materials. The published texts were compared with international texts during research exchanges with Professor Liu explaining in detail how their textbooks related to Singaporean and Korean textbooks. A similar system was in place in Hong Kong with all local bookstores stocking a huge range of the school textbooks used in class, the department of education produced additional resources for teachers based upon feedback from lesson studies which were then published by the textbook publishers for a reduced rate. I have also recently had the pleasure of hosting representatives from the Department of Education in Hong Kong who visited the UK to develop the resources they used for STEM subjects. Thus, a continual cycle of international comparison and exchanges, lesson studies and focus groups with teachers and cooperation

with publishers ensures regular development of the textbooks and support materials with easy access for parents to the materials used in class.

In China the children take home the class textbook for parents to use at home with their children. Parents are informed which pages or concepts will be studied during the week and parents ensure their children are familiar with the taught concepts before the lesson in class. There is thus a strong relationship between the taught lessons and work completed at home, with textbooks provided by the government as part of the school provision. In Shanghai I was therefore interested in whether there are other such texts outside of the government produced text books and what formal support in terms of tutoring is available. Whilst other texts do exist they are of inferior quality to the text books and do not provide any form of support for parents. Upon discussion with staff and parents at YK Pao Primary School I realised that parents rely solely upon the class textbooks as well as information provided by the class teachers. All teachers provide parents with their personal mobile phone numbers and are available to help parents should they need the support. Whilst tutors were occasionally used, their inferiority compared to class teachers was well recognised. Thus, the model is slightly different in China – the publishers produce high quality textbooks which all schools in the district purchase – these are taken home every evening and form part of the set homework. Teachers are expected to provide enhancement materials and the parents rely primarily upon their guidance and support to enhance learning at home.

For teachers in Asia the textbooks provide a structured interpretation of the curriculum which supports joint planning. In Shanghai, this is demonstrated at weekly planning meetings where each chapter of the text book to be completed is discussed and teachers share concerns or advice as to the best methodology to teach the chapter studied. Thus, the textbooks provide a structured format the teachers can work through sequentially and thus focus more attention upon other aspects of their role than lesson planning as lesson plans are shared between teachers and even online between schools. A section of a chapter is prepared a week in advance, and the chapter a term in advance.

The impact of this structured approach was highlighted in Hong Kong where over the period of a week I watched lessons in three different schools on the topic of the trapezium. The second school I visited, Yaumatei Catholic Primary School, was intended to be a contrast to the other two schools. Located in a recent government and privately built joint initiative close to the new port developments that have seen a historic part of Hong Kong reclaimed and developed into luxury houses and shopping complexes with the majority of the students coming from affluent families. The behaviour of the children here was impeccable with many children clearly prepared for the lesson through homework and through private tuition. However, the lesson structure was the same as the other schools and followed the exact same curriculum structure. The teacher extended the brighter pupils in the same manner as the other schools and provided challenging questions and mixed-ability grouping for the less able. The fact that the same lesson sequence was delivered across Hong Kong at the same time in all schools demonstrates the quality of the curriculum structure of the Hong Kong curriculum and how using the same textbook across schools ensures a continuity of approach regardless of the demographic nature of the schools.

The UK government has already encouraged publishers to develop textbooks in response to the methodology used in Asia with two Singaporean textbooks trialled by Maths Hubs

across the country, with, 'the feedback we are getting from teachers and pupils so far is overwhelmingly positive, not least due to the workload savings that a well-designed textbook can provide.' (Gibb, 2018) However, it is important that we develop the link between all sectors of the mathematical community to ensure that the textbooks produced in the UK are responsive to the demands of researchers as well as teachers and schools. It is also essential that these textbooks do not merely reflect the East Asian approach but have been adapted to the demands of the UK National Curriculum and existing pedagogy. Whilst most schools across Hong Kong used the same textbook, the range of texts used in Taiwan to meet the demands of different regions would suggest that textbooks should not provide one standard for all schools, as, 'We should encourage publishers to produce a variety of textbooks of different types that enable schools to choose ones that fit their teaching and are right for their students.' (Merttens, 2015) Thus we should focus upon ensuring our textbooks support the National Curriculum, then develop them through additional support materials produced through research groups comprising of academic researchers and practitioners.

Role of Homework

The TIMSS 2007 survey highlighted that, 'students whose parents reported many resources for learning had much higher achievement than students whose parents had some or few resources.' (Mullis, 2008) Whilst Asian countries perform consistently highly in the TIMSS survey, they do not necessarily have the highest average number of educational resources in the home. This would suggest that it is not the volume, but the quality of the resources used to support learning in the home which is crucial.

In Shanghai textbooks are taken home every single day and parents are told which pages the children will be studying in class through daily contact via e-mail and text messages 'mobile phone apps used by Shanghai teachers included parental contact lists which were used daily. Parents expect daily communication from their schools and await text message alerts.' (NCSL, 2014) As the textbooks have passages explaining the concept taught, often introduced through a cartoon character such as a panda, and often provide instruction on common misconceptions the children will encounter, parents can prepare their child in confidence that their support at home will match the pedagogy of the classroom and they will have support in the textbook if they struggle with the concepts taught. This combined with the opportunity to contact the teacher out of normal school hours to ask questions about the homework and receive further clarification provides strong extended learning outside of the classroom and continuity between home and school.

In Shanghai one parent explained that his child practised mathematics daily and, as far as he was aware, this was the same for all other families. This work consisted of using an exercise book of drills to increase understanding of calculation strategies and improve calculation speed. The parent was thus reinforcing the fluency with which his child could complete the strategies taught in school. In addition to this, technology supported Mathematical learning at home with exercises on the Internet and school websites. With education regarded as critical to future success it is not surprising that East Asian families spend considerably large proportions of their income on education, as, 'The Chinese parents, across all SES groups in the survey, reported that, after food, education was the second highest household expenditure with 55% reporting the hiring of tutors and 76% indicating that they would borrow money for their child to go to college.' (Tsui, 2005)

Homework is also flipped at the weekend to focus on curriculum content not yet taught. This enables complex misconception analysis on Monday with homework adapted during the week to focus upon revision and practice of key misconceptions and areas of difficulty. The teachers spend a great deal of time marking the homework, particularly on Monday morning before class, which is then used to inform their practice during the week. The textbooks and homework questions are usually multiple-choice and thus easier to mark and are designed to offer quick yet detailed feedback to the teacher. Maths is also taught during the morning to ensure that, 'class and homework can be assessed immediately - a virtuous cycle assessment supporting learning.' (NCSL, 2014) Thus, children receive feedback immediately whilst their homework is fresh in their minds and the afternoons can be used for interventions if needed.

Having children arrive at school prepared and aware of what the expectation of the lesson is and aware of concepts they will find challenging enables the class teacher to focus less upon procedural knowledge and more upon problem solving and investigations. Too often in the UK the children arrive to the class aware of the theme to be studied in class or the unit of work they are studying, yet unprepared for the content of the lesson. Parents are communicated as to the objective of the lessons to be studied over a term or a week but rarely receive the detailed support observed in Asia, with homework largely focused upon practice of concepts already taught.

With the recent governmental research into a recommended national textbook, whose selection criteria included, 'ensuring that there is a comprehensive set of teacher manuals with curriculum content and pedagogical guidance and hard copy pupil text books and practice exercises, having assessment activities and teacher guides that enable teachers to anticipate and plan how to tackle misconceptions.' (TES, 2017) There should be an option to include detailed resources for classroom usage which can be adapted or shared for home usage.

Role of Support

We are beginning to witness many changes within the UK in terms of how we define success in the primary school. There is increased awareness of the importance of progress as well as academic attainment at KS2 and we are also no longer defining expected progress as pushing children above their year group level but looking at the depth with which we are asking the children to explore their learning.

Many schools are introducing a mastery approach to maths where immediate interventions are used where, 'those who do not reach the required level are provided with additional tuition, peer support, small group discussions, or homework so that they can reach the expected level.' (Education Endowment Fund, 2017) However, we are yet to witness a shift in timetable expectancy where teachers are given time to run interventions, work in teams to support individual children or given sufficient time out of class to design high-quality interventions to effectively support children who have not met the expected standard. The interventions are thus often left to teaching assistants and research has shown that, 'Those pupils receiving the most support from TAs made less progress than similar pupils who received little or no support from TAs.' (Sharples, Webster and Blatchford, 2015) Whilst we are beginning to adopt the idea of immediate interventions from Asia, there is still a lot to be learnt from the approaches I witnessed as part of my research.

Many of the schools I visited taught children from areas of social deprivation or included children with individual learning needs in the mainstream classroom. The teachers spoke about the extent of extra support and intervention needed to ensure that all children in the class can master the taught concept fully. These interventions sometimes were quick five-minute catch-ups over break or lunchtimes but with children with more severe learning needs they took place after school with the class teacher or a specialist support teacher. Regardless of the socio-economic background of the children, the expectation was that all the children would achieve the expected standard and teachers worked harder to ensure every child achieved expected.

With all the schools I visited, the actual time the teachers spent in the classroom was reduced to between 3 and 5 lessons per day, with each class lasting 40 minutes. 'Describing a typical day, teachers emphasised the importance of setting homework, checking it and collating questions on challenging topics; making pupils repeat work so that they can learn from their mistakes. Teachers also provide private tuition after-class, though it is the child's responsibility and not the teachers to ensure attendance and completion of work. The rest of their time is used to plan, mark and tutor children who have struggled in a lesson.' (NCSL, 2017) Thus, the teachers have the time and space within their school day to support children who are not meeting the expectation of the lesson. One of the schools I visited was The Church of Christ in China Kei Tsz Primary School in Kowloon in Tsz Wan Shan which is in an area with high levels of deprivation, on a social housing estate built in 2002. This school was identified for its excellent teaching as well as for its commitment to ongoing professional development and creative ways in which it supported children with individual learning needs. The two classes I observed investigated the geometric properties of trapeziums and encouraged students to experiment practically with the trapezium and identify how many different forms could be made. These we collated on the board and the

different types of trapezium were identified. The teaching was student-centred with the teacher identifying misconceptions and developing learning through careful questioning. In the post lesson discussion, I asked the teachers how they managed the range of student abilities in the class. They identified that the school had teachers who were dedicated support for children with individual learning needs who would provide 1-1 support for these children during the afternoon lessons and after school. They also discussed how they spend their lunch and break times providing immediate support to children who were not able to fully access the taught content. The described the pressure as immense as they were expected to teach a full workload as well as provide additional support to children unable to meet the needs of the class. Interestingly, they also provided extension for the more able students through challenging questions or additional homework.



This model of immediate intervention is already beginning to gain interest in the UK with many schools providing afternoon support for children struggling to understand the key concepts taught in class. What is striking about my research was the pressure the teachers felt under to achieve the expected results for all students and the necessity of additional adults to support them due to the complex nature of their classes. It was clear that a highly structured curriculum, textbooks and homework were insufficient in meeting the needs of all of their children, particularly the children with individual learning needs or who came from families who were unable to support their children at home. Thus, any implementation of a mastery approach should ensure that provision is in place for the children not able to fully access the curriculum or receive support at home. Furthermore, a recognition of the challenges faced with a mastery approach for schools working in challenging circumstances

should be encouraged as a few teachers in Hong Kong expressed their dissatisfaction that they were expected to work longer hours, provide support in their breaks and lunchtimes and tutor children after school due to the socio-economic background of their children whilst their colleagues in more affluent areas did not have to work so hard. This problem is an ongoing issue within education, yet mastery is often implemented in schools in the UK as a way to ensure equal access for all children, yet in Asia it is clear that for some students ensuring mastery involves considerable amounts of intervention and extra-curricular support.

Culture

Much has been written about the Confucian nature of ancient Chinese society and the influence it has upon education today. Historically, traditional education in China was closely associated with the recruitment of officials through examinations, which required extensive knowledge of the Confucian classics. Education was seen as the way to achieve the dream of entering the civil service, which was achieved through memorising the Confucian classics for the civil service examination. After military conflict in the mid-19th century, many questioned Chinese superiority in the world and the underlying educational system, and the civil service examination was abolished in 1905, leading the way for an approach to education heavily influenced by the West. However, 'although the content of education has changed considerably before and after the founding of republic, what has remained intact with Chinese mentality on education is that they have had a sheer pragmatic view on education and knowledge. During the old days in the country where poverty and hardship had hit millions of lives, education by means of civil service exams had turned out to be the means for social upward mobility.' (Chan, 2006) This belief in the power of education to promote upward social mobility is ingrained in Chinese society, that it is only through education that you can progress to the higher levels of socio-economic success and that this can be achieved regardless of your social class or financial background, but through dedication and hard-work. In fact, one of the most well-known Confucian maxims on education is, "in teaching there should be no distinction of classes" (有教無類), which has a truly equalitarian spirit.' (Chan, 2006) I observed across all the schools I visited a recognition that the brightest children would progress to the best schools, but all children deserved the right to their education and more importantly, that every student has the right to succeed at the expected level. Whilst adaptations were made for children with individual learning needs, the expectation of expected levels of attainment still remained.

We thus cannot ignore that the Chinese educational system is deeply rooted in a values system that places education of central importance to socio-economic success and that the UK may face challenges adapting the Asian approach to maths to the UK context yet there has been an underrepresentation of the importance of adapting the Asian approach culturally to the UK partly because, 'all too often schools and teachers are written about as if they somehow sit outside the overarching culture, attitudes and policies of their nation states. Obviously this is not the case, education systems are part of the broader cultural milieu. Culture, beliefs and dispositions have all come through strongly as powerful influences in learning mathematics.' (Askew et al, 2010)

We are thus faced with the question as to whether the high attainment observed in Asia may be much more closely linked to cultural values than to specific mathematics teaching practices and whether being born into a culture that highly values success in education, particularly mathematics establishes a cycle of continuing success where the expectation of high attainment and positive attitude towards mathematics creates a culture where success is expected and achievable. Parental attitudes towards mathematics, shaped in Asia by the respect for education and desire for increased social mobility combine to create situation where, 'Students whose parents have high expectations for them – who expect them to earn a university degree and work in a professional or managerial capacity later on – tend to

have more perseverance, greater intrinsic motivation to learn mathematics, and more confidence in their own ability to learn and use mathematics than students of similar socio-economic status and performance in mathematics, but whose parents hold less ambitious expectations for them.’ (OECD, 2013) This increased confidence in turn creates positive mathematicians as, ‘Students whose parents hold ambitious expectations for them are more likely to have positive perceptions of themselves as mathematics learners, to have high levels of drive and motivation, and are more likely to be engaged with school’ (OECD, 2013) This balance of high motivation and positive perception of themselves as a learner is crucial in creating motivated and successful students.

In Taiwan I visited Dongmen Elementary School in the newly developed high-technology zone of Hsinchu. Here I observed mathematics teaching that involved a technique developed by the university – categorisation. Children were asked to organise shapes according to their features and consistently redefine their categories in the light of discussion. During the post-lesson discussion, the teacher explained how as part of their work with the university they are developing this approach to meet the needs of her school. Her method provided a structure to analyse the concepts taught through a careful definition of the properties of the concept studied.



The next school I visited was the Affiliated Experimental School of National Taichung University which pioneers an approach based upon creative arts. The mathematics teacher followed a similar system with their lesson and a post-lesson discussion centred on the needs of the local community requiring increased parental engagement which is done through the arts. During the visit, I was fortunate enough to watch a performance given to

parents based around dance and the Head Teacher discussed how performance arts has enabled the school to become engaged with a largely socially disadvantaged community.

Both schools thus demonstrated an adapted approach to the needs of their local community whilst still working to the high levels of expectations of the maths curriculum in Taiwan. This was repeated across my observations, with a school in China choosing to use a harder curriculum than the one recommended by the local authority to meet the needs of their children, and through the work of the mathematics department of the ministry of Education in Hong Kong as well as the Universities in Taiwan to provide support and adaptation materials to enhance the curriculum for the local context.

There is thus a high cultural expectation of success which was expected across all schools visited with the systems in place to ensure that all children could access the curriculum and attain the high expected standard. This contrasts sharply with the attitudes towards education and mathematics in the UK where, 'It is culturally acceptable in the UK to be negative about maths, in a way that we don't talk about other life skills. We hear 'I can't do maths' so often it doesn't seem a strange thing to say. Maths is seen as the remit of 'mad scientists', 'nerdy' boys, and the socially inept. We talk about maths as though it is a genetic gift possessed only by a rare few, and inaccessible to the general public.' (National Numeracy, 2018) Without addressing the negative perception of mathematics in the UK it is inconceivable to consider a mastery approach having the same effect upon our learners.

Teacher Training

Taichung is an industrial city and the third largest in Taiwan. I had the pleasure of visiting the Affiliated Experimental Elementary School of National Taichung University – an impressively designed campus next to Taichung University. I spent most of the day with the mathematics department at the university discussing the resources they produce, the approach to teacher education as well as the role of parents in supporting their children’s education. The importance of a highly structured teacher education programme was stressed with the university providing both the initial teacher training and support for ongoing professional development. This was evidenced through the visits I made to local schools, all of which were either engaged with current professional development projects or were the workplaces of former students. There existed a strong culture of respect between the university lecturers, the school principals and the teachers. Interestingly, if a school is struggling or requires support with individual teachers the support they receive first is from the local University who actively engage with schools, the department of education and local policymakers.

On Christmas day, I had the pleasure of joining 15 maths experts from across Taipei for a lesson study session at Taipei Mandarin Experimental Elementary School. The atmosphere was incredibly jovial as the experts had worked together closely for many years. The teacher presented her lesson plan and discussed areas she thought the children would find challenging. We then observed her class, with each adult given 4 children to observe closely. The post-lesson discussion was intricate and focused upon children’s misconceptions and their reasons for them, demonstrating a commitment to analysing mathematics at a very close, specific level but also highlighting the depth of understanding the teacher had of each individual child. The class teacher not only predicted how each child would behave but was able to relate the feedback to specific activities she could complete to support the children in future work. This highlighted the role of prior-assessment in lesson planning and how a mathematics specialist teacher can understand a child’s ability in a depth I have not witnessed in the UK. This group of professionals played an important role in the local area, they supported teaching staff in their own schools, worked across schools to develop best practice and implement new initiatives and worked with the local authority to support struggling schools and staff. We are beginning to reproduce this model in the UK with the development of Maths Hubs and Mastery specialist teachers which encourage discussion and support across schools, whilst actively involving universities and policymakers in the development of training, resources and policy. What fascinated me about this process in Taipei was how the process supported the class teacher to develop her career as well as creating a strong community of maths experts – over lunch they discussed how they had been working together for many years and even showed me photos of their group holidays they take to the beach!



The final school I visited in Hong Kong was Ma Tau Chung Government Primary School which is located on the edge of traditional social housing complexes and new developments. It was described as a school that under careful leadership has developed its quality of provision and this was clearly evident from the enthusiasm and pride the Head Teacher took in her school and the awareness of the changing local environment and threats of gentrification. The lesson observed was taught by a teacher who was currently participating in a mentoring project with the board of education. The theme was the trapezium and was a development from the previous lessons, focusing upon the angles created when bisecting trapeziums and creating perpendicular angles. The depth of subject knowledge needed to teach this topic highlighted the importance of subject specialists in primary mathematics. In the post-lesson discussion, the representative from the board of education raised an error the teacher had made when describing one of the bisected angles. The openness with which the teacher accepted the advice and engaged in a frank and open discussion of the error highlighted the strong respectful relationship between the government departments as well as the power of the lesson study approach used in schools in Asia. I asked whether the teacher would mind having her errors pointed out, the response was incredulity at my question as the role of a teacher is seen as continual improvement through reflection and support from peers and senior members of staff. We also discussed how the teacher undergoes a process of continual professional development involving lesson study, support from the local government and participation in local mathematics forums. The school is aware of the pressure this places upon teachers and has adopted strategies from mainland China including study rooms and teachers lounges to provide relaxation spaces for staff.

One of the great strengths of the approach used in East Asia is thus the support for teachers at all stages of their career and the openness with which they engage with observations and critical feedback. One of the issues within the UK may be the close link with performance management and lesson observations and encouraging a mentoring approach may be beneficial. It is also interesting that the universities work closely with the schools, often taking on a role that has traditionally been conducted in the UK by the local authority or agencies such as OFSTED. Having such close links to educational researchers and devolving observations from performance management may ensure that our class teachers feel supported and develop research based pedagogy.

Conclusion

My research has taken place during an exciting time for UK mathematics and it has been interesting following the development in understanding of the approaches used in Asia and their implementation to UK schools. Visiting such a range of schools with unique challenges has enabled me to observe how the Asian model of mathematics is adapted to meet the expectations and needs of each school and community.

In each of the countries visited there was a careful balance of national expectations, consistent challenging curriculum, standardised textbooks and communities of researchers and teachers supporting excellent practice. The implementation of Maths Hubs is one way in which the government is encouraging this practice in the UK with an increasingly large number of schools trained in mastery approaches.

Of concern is the lack of recognition still within research in the UK as to the extent of additional support provided by class teachers to students in Asia who do not meet the expected standard. I am unsure whether within my own practice I could expect my staff to show such dedication as witnessed in Hong Kong, Taiwan and China, with teachers using their non-contact time, lunchtimes and evenings to supporting students. We do however need to address this issue to ensure that interventions are used in the UK to ensure no children are left behind.

Since completing my travels I have had the pleasure of working closely with the schools I visited in China and the Board of Education in Hong Kong. I have disseminated my findings on training courses and through links with my local Maths Hub. It has given me the confidence to implement a mastery system that works for my school and the unique challenges of our community and support local schools develop an approach that works for them.

References

Askew, M., Hodgen, J., Hossain, S., and Bretscher, N. (2010) *Values and Variables: Mathematics in high performing countries*. Nuffield Foundation

Boaler, J. 2015. *The Elephant in the classroom: helping children learn and love maths*. Souvenir press, 2nd edition.

Education Endowment Fund. 2017. *Mastery Primary Report* . [ONLINE] Available at: <https://educationendowmentfoundation.org.uk/resources/teaching-learning-toolkit/mastery-learning/>. [Accessed 2 January 2017].

Lotman, J., Uspensky, B. 1978. "On the Semiotic Mechanism of Culture," *New Literary History*, pp. 211-32.

Merttens, R. 2015. *Why are we blindly following the Chinese approach to teaching maths?* . [ONLINE] Available at: <http://www.scmp.com/news/hong-kong/article/1980822/one-sevehttp://www.theguardian.com/teachernetnetwork/2015/feb/10/chinese-teaching-primary-n-hongkongers-are-deprived-study-finds-only-third-these-are>. [Accessed 2 January 2017].

Mullis, I.V.S., Martin, M.O., and Foy, P. (2008). *TIMSS 2007 International Mathematics Report: Findings From IEA's Trends in International Mathematics and Science Study at the Eighth and Fourth Grades*. Chestnut Hill, MA: Boston College.

Nick Gibb: Importance of core knowledge sees return of textbooks - GOV.UK . 2018. *Nick Gibb: Importance of core knowledge sees return of textbooks - GOV.UK* . [ONLINE] Available at: <https://www.gov.uk/government/speeches/nick-gibb-importance-of-core-knowledge-sees-return-of-textbooks>. [Accessed 07 January 2018].

Nick Gibb: building a renaissance in mathematics teaching - GOV.UK . 2018. *Nick Gibb: building a renaissance in mathematics teaching - GOV.UK* . [ONLINE] Available at: <https://www.gov.uk/government/speeches/nick-gibb-building-a-renaissance-in-mathematics-teaching>. [Accessed 07 January 2018].

National Numeracy. 2018. *Attitudes (what is the issue?) | National Numeracy*. [ONLINE] Available at: <https://www.nationalnumeracy.org.uk/attitudes-issue>. [Accessed 07 January 2018].

NCSL, (2014). Report on the international Maths Research Programme, China 2014. Nottingham: NCSL.

Sharples, J. Webster, R. Blatchford, P. 2015. *Making Best Use of Teaching Assistants Guidance Report*. 1st ed. Education Endowment Fund.

“Teaching the Chinese Learner in higher education” Friday, March 17, 2006 Leiden University Historical and cultural background of education in China Mr. Chi-hou CHAN, M.A., PhD candidate and Lecturer, Sinological Institute, Leiden University

Tes. 2017. *List of approved maths mastery textbooks has just one entry | News*. [ONLINE] Available at: <https://www.tes.com/news/school-news/breaking-news/government-approves-just-one-maths-mastery-textbook>. [Accessed 07 August 2017]

Tsui, Ming (2005). Family income, home environment, parenting and mathematics achievement of children in China and the United States. *Education and Urban Society*, 37(3):336–355.

OECD (2013), PISA 2012 Results: Ready to Learn: Students’ Engagement, Drive and Self-Beliefs (Volume III), PISA, OECD Publishing. <http://dx.doi.org/10.1787/9789264201170-en>

Elite teachers travel from Shanghai for pioneering maths exchange - GOV.UK. 2017. *Elite teachers travel from Shanghai for pioneering maths exchange - GOV.UK*. [ONLINE] Available at: <https://www.gov.uk/government/news/elite-teachers-travel-from-shanghai-for-pioneering-maths-exchange>. [Accessed 07 August 2017].