Based on comparisons of TIMSS results from 1995-2015, along with teacher perspectives, can the incorporation of Singaporean and Swedish teaching approaches improve mathematical achievement in England's primary schools?

Zaynab Miah
Supervisor: Adrian Warhurst

BA (Hons) Primary Education with QTS
Newman University

Acknowledgements

"After all, the ultimate goal of research is not objectivity, but truth." ~Helene Deutsch

First and foremost, I would like to thank my supervisor, Adrian Warhurst, for opening my eyes to the fact that educational research is not only about discovering answers to a question, but to illuminate an issue that may well help solve a problem faced by a small community or institution. The time you took to discuss and provide insightful feedback towards my research, as well as your enthusiasm to read my drafts, were most definitely a source of motivation for me and will always be much appreciated. I left every meeting having learnt something new- a great feeling!

I would also like to take this opportunity to thank Claire Owen. Alongside being a supportive APT who replied to emails at impressive speed, she presented herself as always being there when we needed advice, and provided us with a series of very clear lectures and PowerPoints to refer back to throughout the dissertation journey which had answers to most queries I had.

Last but not least, it is with sadness that I will soon no longer join good friends who worked alongside me at Newman's excellent library, somewhere we so enjoyed working and researching in the company of one another…and so, yet another chapter in life closes.

Abstract

Mathematical underperformance in England's schools is a topic of discussion that is prevalent amongst policy makers, who adopt the view that policy borrowing from top performing countries on macro scale studies such as TIMSS provide answers to the transformation of pedagogy, which is seen as the main driver of success or failure in the subject. The search to address reasons behind its underperformance was furthered in this research, with a focus on investigating whether the positioning of Singapore and Sweden in TIMSS' Grade 4 data should be a determinant of whether or not England should borrow pedagogical ideas from them to improve their overall mathematical achievement in primary schools. The study also took into account aspects of cultural variations and differences in teachers' experiences within each of the education systems to gauge an overall idea of why each country might be where they are in TIMSS data. On the whole, the study was guided by four research objectives:

1. Compare TIMSS mathematics results from Singapore, Sweden and England (1995-2015)
2. What are the main similarities and differences in maths teaching between the countries and how does this affect the progress children are making?
3. What are teachers' views on the adoption of Singaporean and Swedish pedagogy in relation to maths?
4. What teaching methods does the evidence from Singapore and Sweden suggest are good candidates for adoption in England to improve levels of maths achievement?

A desk based study which considered a mixed method approach to research was adopted, and both qualitative and quantitative secondary data were utilised through reference to numerical scores achieved in TIMSS and the views of a number of teachers. These views were extracted from survey data, but mainly through interviews conducted recently that had been collated in academic, peer-reviewed journals.

Findings highlighted that though approaches such as Singaporean mastery are improving mathematical progress, borrowing pedagogical ideas presents itself as being an extremely challenging process, as cultural differences are not taken into enough consideration by policy makers, hence England's inability to match TIMSS scores of top performing countries such as Singapore despite attempts to emulate their maths practice. Moreover, the argument that England is not considering Swedish practice despite their similar values and long-term aims in mathematical progression due to their lower TIMSS scores was put forth. It also took a turn through questioning why, despite obtaining decent scores which place it close to the high benchmark of mathematical performance throughout its involvement in TIMSS, does England feel the need to change its pedagogical ways so drastically?

Future research could focus on the extent to which high achieving nations look towards western countries to improve their educational approach, and also whether SEN children benefit and progress equally as well to pedagogical borrowing as their peers.

Table of Contents

Chapter 1: Introduction

1.1 Focus of the dissertation

One of the most significant discussions in education research is that of the continuingly low mathematical performance true of a large proportion of pupils in England, which is only worsening (Smithers, 2004; Adams *et al.,* 2016; Hodgen *et al.*, 2018; UCL Institute of Education, 2018). Much statistical data directs attention towards the severity of this issue, by revealing a negative correlation between rising age and numerical skills, whereby 1 in 4 adults regard their mathematical education as insignificant to their everyday need of it (Department for Business Innovation and Skills, 2012, pp.3-6; National Numeracy, 2018). Paterson *et al.* (2010) offer critique of such statistics through referencing the government's increasing propositions of current initiatives, predominately international, directly aimed at boosting numeracy skills. They do however acknowledge the negative impact teaching transitions between primary and secondary may have on pupil progress.

As a result, the National Numeracy Strategy (2018) imply that England risks becoming 'less competitive internationally'. However, an alternative argument by the National Foundation for Educational Research (NFER) (2018) advocates that such competition in terms of results could offer invaluable insight into the commodities of alternative education systems, which can then be scrutinised for ideas and adopted in terms of relevance to the country in question's needs.

1.2 Dissertation Aims and Objectives

This study therefore aims to discover why, after all the international data gathered in TIMSS, do national shortcomings in numeracy not improve more significantly? It will critically examine both Singaporean and Swedish TIMSS results in comparison to England, and then comment on whether the countries are beneficial in terms of lending pedagogical approaches to teaching maths in England, regardless of their international rankings.

Moreover, it will explore whether a country's positioning in TIMSS is enough to determine whether their pedagogical ways should be altered to match those topping the tables. The aim is to also examine issues teachers face within the wider context of maths teaching, which could consequently determine how they teach and receive the results they do.

Alongside the research question, the following four key objectives were developed in order to guide the development of themes, help obtain relevant literature and also inform a conclusion.

1. Compare TIMSS mathematics results from Singapore, Sweden and England (1995-2015).
2. What are the main similarities and differences in maths teaching between the countries and how does this affect the progress children are making?
3. What are teachers' views on the adoption of Singaporean and Swedish pedagogy in relation to maths?
4. What teaching methods does the evidence from Singapore and Sweden suggest are good candidates for adoption in England to improve levels of maths achievement?

Chapter 2: Literature Review

2.1 A look at culture and the adoption of international pedagogical styles in an attempt to improve mathematics outcomes

The concept of borrowing educational ideas from international counterparts is not one that involves the emulation of one single country, but rather, seeks to adopt ideas from various successful education systems in order to challenge and draw out alternative approaches that may be working insufficiently (Schmidt *et al.* 2002). In 1996, Ofsted proposed that it was a necessity that English educational establishments looked East for new pedagogical practice if they were to fill academic gaps appearing in pupils' learning when compared to international counterparts (Alexander, 2008, p.9). Such cross-national practices can be dated back to previous years and are still prominent now (Ball, 1994, cited in Phillips and Ochs, 2003), suggesting that their collective motive is to raise mathematical teaching standards and student attainment (Ochs, 2006, p.602-603). Alternatively, Jenkins (2016) argues that easy accessibility of numeracy results make it easy for international measurement, which he argues, is unfortunate. This leads to the suggestion that if higher expectations are required of maths teachers in England, teacher views towards the subject require change, and policy makers should understand the gravity of their ask, as the cultural differences vary significantly in East Asian countries, not only in schools, but equally in home environments thus resulting in higher maths results amongst East Asian children living in western countries (Jerrim, 2015, pp.311-329)

In a recent publication by the Organisation for Economic Cooperation and Development (OECD) which focuses on what makes high-performing education systems different, Schelicher (2018) points to some crucial factors that are relevant to countries seeking pedagogical emulation from such systems. Firstly, taking cultural context into consideration could determine whether certain policies and practices result in high achievement solely in jurisdictions that hold similar traditions (Alexander, 2010, cited in Crisp, 2013). For instance, cultures based on Confucian traditions, Singapore being one, are known for emphasising educational value and high achievement as a result of hard work through testing and examinations (Chia and Toh, 2012, cited in Crisp, 2013), leading observers to attribute this to their educational success. Schleicher (2018) also acknowledges arguments against cultural consideration by pointing to various countries that have evidently improving student performance rates due to the borrowing of practice, and not, he argues, because of a change in culture or teachers.

In his research, Williams concludes that for primary schools to maintain high mathematical standards, the pedagogical approach which educators adopt should maintain high levels of confidence and enthusiasm (Royal Statistical Society, 1995, pp.3-6; Williams, 2008, p.1), something that England lacks due to a large percentage of the population expressing negative attitudes towards maths (Brian, 2012; Garner, 2012; O'Leary *et al.* 2017, no page number). The Royal Statistical Society (1995) make it clear that teachers are not solely blameworthy for poor results, however, others do blame the unimaginative manner in which maths is taught (Gowers, 2016; Jenkins, 2016). Therefore, Williams (2008, pp.3-4) proposes such feelings of negativity should be disposed of through continuous professional development (CPD) at work, as they are not necessarily alleviated in the training period.

From the research above, it seems logical to look to other countries for answers to raise mathematical performance, which is consistently falling below government expectation (House of Commons, 2008-09, p.3; Kuczera *et al.* 2016). Nevertheless, Roberts (2018) argues policy makers are coming to hasty conclusions which do not necessarily look towards countries based on successful, creative teaching approaches, but rather, due to positions held within tables such as TIMSS. Greany *et al.* (2016) point towards the upward trend of pupils' mathematical performance in England in each year they have participated in TIMSS (Appendix 1), but the NFER (2016, p.2) take an alternative stance when comparing results, as they disagree that minor increases in scores prove that maths has progressed. Consequently, both English and Swedish pedagogy would not be considered prior to their Singaporean counterparts who have consistently topped the TIMSS board (Hill, 1997; Coughlan, 2016), hence the large amount of interest surrounding their teaching mechanisms.

For years now, government documents have highlighted East Asian countries as topping international tables, and thus there is pressure to emulate their teaching practices to gain higher positions in league tables, which, Sharma (2015) argues, is a difficult procedure. She acknowledges that their outstanding successes may link to varying teacher training, values, competitiveness and parental expectations.

2.2 A look at TIMSS and the effects it has on pedagogical reform in maths

Trends in International Mathematics and Science Study (TIMSS) is organised by the International Association for the Evaluation of Educational Achievement (IEA). It is carried out every four years and focuses on the learning and teaching of mathematics and science (Harris, 1997; Educational Research Centre, 2019; IEA, 2019). Results obtained are analysed by policymakers worldwide, and the highest achieving nations are looked towards for ideas on, in this case, pedagogical reform to improve mathematical achievement in England's upper primary schools (Department of

Education, no date). Various viewpoints have emerged on the effects of such international assessment driven movements, with O'Shea (2016) arguing that a 'culture of testing' is prevailing whilst curriculums lose their characteristic national differences due to their international competition with little regard for cultural variance. This breaches England's intention to decrease primary level testing to focus less on league table data and more on students themselves (Jones, 2018; More than a score, 2019).

Currently, England appears somewhat fixated on the idea that mastery is the way forward for progression (Department for Education, 2013), and one argument for this could be that countries, such as Singapore, both use this approach and continually top international league tables. Adopting mastery could be seen as a needed change from rapidly accelerating learning through levels to allow deeper understanding prior to moving on (Department for Education, 2014; NCETM, 2018; Maths No Problem!, 2019), as movement through levels lacks validity due to the varying models of each level that mean pupils can reach the same level despite some not performing as well as their peers (Department for Education, 2014).

2.3 Similarities and differences in pedagogical approaches between England, Singapore and Sweden, and effects that these may have on pupil progress

First and foremost, Wang *et al.* (2003, p.4) believe it is necessary to recognise countries that excel mathematically do not utilise a single teaching approach, and secondly, they are likely to properly train teachers to deliver the subject thoroughly.

2.3.1 Singapore:

Through focusing on differing teaching styles in England and Singapore, Cartwright (2017) points to some of the main styles adopted by Singaporeans that determine their international success. These include their strong cultural commitment to educational excellence (OECD, 2010, p.165), a focus on greater depth instead of curriculum progression through a whole-class teaching approach, and finally, the explanation of abstract concepts through a systematic visual process (Gorard *et al.,* p.43). More specifically, Guan *et al.* (2017) highlight various curriculum initiatives teachers attend to enhance content knowledge before proceeding to teach the subject, which aim to provide an in-depth knowledge of what they will teach in the primary curriculum. Notably, there is significant focus on the willingness to stretch and challenge pupils with the underlying belief that all can achieve and enjoy maths (Boylan, 2016). Lim (2012, cited in Crisp, 2013) suggests the reason behind such high success rates is down to a system that focuses on test performances and grades, thus pressurising all students to compete. Interestingly however, Singapore (Singapore Government, no date), England (Ofqual, 2018) and Sweden (Petterson, 2004) all administer national tests (a large section of which test numerical ability). However, research shows that whilst Singapore plans to discontinue Primary School Leaving Examinations (PLSE) due to excessive student pressure (Wood, 2018), and England pledges to scrap SATs tests to decrease teacher accountability stress (George, 2019; Richardson, 2019; Weale, 2019), Sweden is still administering reforms to the curriculum that are concerned with grading (Olovsson, 2015).

Contrary to Merttens' (2015) argument that the Singaporean curriculum follows a prescriptive text-book style they believe works for all pupils, Drury (2016, cited in

Maths Mastery, 2018) focuses her attention on the emphasis of group discussions which are apparent from classroom layouts and puts forth the argument that lessons are varied and engaging. This complements the Singaporean National Institute of Education (NIE, 2018)'s prescription that teachers should avoid being dispensers of knowledge by facilitating sense-making and reasoning in pupils in order that they connect how meaningful maths is to their daily lives (NCTM, 2018, p.1). That is not to say that direct teacher instruction in terms of demonstrating new concepts and skills is not utilised. Rather, the technique of model thinking aloud to make mathematical processes clearer whilst providing pupils with questions to assess understanding is emphasised in The Singaporean Mathematics syllabus (2013). Nevertheless, the syllabus makes it clear that this is one of many pedagogical approaches attempting to consolidate mathematical understanding through mastery, which requires teachers to cyclically provide numerous activity based lessons, allowing learners to both practice and work simultaneously with concrete objects to acquire problem solving skills and decipher concepts otherwise abstract to them. Consequently, students surpass western counterparts in problem solving (OECD, 2012, cited in Deng and Gopinathan, 2016) and maths (Gurney-Read, 2016), both of which they have achieved top rankings in.

2.3.2 Comparisons between England and Singapore

Rudock and Sainsbury (2008) propose that England consistently score respectably when comparing their maths scores to international counterparts, and thus put forward proof of similarities in depth and breadth of the English and Singaporean curricula. Overall, they conclude that England's curriculum does not differ significantly to Singapore besides a higher focus on data handling and ICT in England, and a greater emphasis on procedural knowledge in Singapore rather than the development of understanding. It might be that developing conceptual understanding is mentioned less in the Singaporean syllabus than England's due to pupils frequently achieving content mastery through securing multiplication facts at a young age (Department for Education, 2012, pp.61-62; NCETM, 2014; Ministry of Education Singapore, 2016). However, when taking into account the time frame of Rudock and Sansbury's research, significant changes have taken place which can be demonstrated through comparing both the recent curriculums published in 2013.

Ironically, England focuses more on solving problems to develop conceptual understanding in order for students to reason, recall and apply knowledge rapidly (Department for Education, 2013, p. 3), whereas Singapore, which now takes into account the importance of ICT in maths, aims to develop a love of maths through active learning, which inevitably deepens understanding and ultimately leads to problem solving through constant reasoning and application (Ministry of Education, 2012, p.19-21). Interestingly, director at OECD, Schleicher (2016, cited in ACME, 2016), refers to England's curriculum as being too focused on covering multiple topics that are taught in a complicated manner with little regard for the fact that teaching fewer topics is more beneficial to greater depth and understanding. He argues that much maths teaching in England relies on memorising and learning facts, thus going against the claim that rote learning is deeply rooted in East Asian culture (Tan, 2010), therefore disagreeing that Singapore could achieve mastery and recognition using rote alone. The comparisons above suggest the rapid recall England expect stems from the belief that rote helps achieve results, however as a result of their policy borrowing from higher achieving nations, the curriculum now gives importance to deeper understanding. It is therefore clear that policy borrowing is taking place, but if both curriculums do not differ significantly, then why are TIMSS results in England not closer in proximity to Singapore?

2.3.3 Comparisons between England and Sweden

In her research on Swedish teaching methods, Hansson (2010) discovers that a student-centred approach characterised by communication whilst learning is used to help students develop a mathematical identity. Seaberg (2015) expresses interest around the emphasis Swedes place on oral communication within maths lessons. In contrast, Brating and Ostermon (2017) suggest this focus on meta-mathematical knowledge (i.e. ability to talk mathematically), along with a rise in practical maths are detrimental to numeracy skill sets, and are a reason for the declining numerical ability amongst Swedish students, hence their lower TIMSS scores. Within the article, they also state that prior to curriculum changes, students demonstrated the ability to complete maths tests with correct answers and methods, something that is no longer the case, and despite being able to accurately describe strategies to solve problems, final solutions are not included. Perry *et al.* (2015) direct further attention towards the emphasis placed on linking maths to everyday experiences, but do address concerns some teachers have with it when considering their status on TIMSS. When considering the British government's overall aim to produce well rounded, skilfully equipped citizens for the world after leaving school (Nick Gibb, 2014), it appears Sweden's approach to teaching maths is predominantly focusing on that, yet England continue to look towards high achieving nations.

2.4 What does research show that stands out most when comparing Singaporean and Swedish teachers' working conditions to those in England, and how might this link to pupil achievement in maths?

Teachers play an instrumental role in producing mathematically academic, skilful pupils through showing overall competency, respect and value of pupils' efforts, producing positive learning environments and knowing their subject well (Abazaoglu And Aztekin, 2016; Eriksson *et al.* 2018). Their own experiences within the education system determine how well they are able to fulfil pedagogical responsibilities (Tennant *et al.,* 2009; Ozturk and Hoard, 2019), thus it is a factor worth researching to determine why countries hold certain TIMSS positions. Hargreaves and Fullan (2012) incorporate a fascinating argument to this issue by stating that the real asset to a successful education system is not frequent curriculum change, but rather the retention of good teachers who should be considered as determinants of quality learning in students. They also point to two visions of teaching, the first being business capital which is present in England. It favours a cost effective, young workforce who are less confident and competent towards maths than their experienced colleagues being replaced. Countries such as Singapore however, through the professional capital view, recognise that large investments must be made in the training and preparation of high quality teachers for education systems to thrive.

2.4.1 England

Although teachers report high levels of confidence in teaching Year 5 (Grade 4) maths, workload challenges and difficulty adapting to curriculum changes result in their low job satisfaction compared to most countries (Department for Education, 2016, p.146). It is argued that as a result, there is decrease in demand to enter the profession

(Carnoy *et al.* 2009, p.166; Coughlan, 2018). Consequently, increasing pupil attainment and motivation in maths being interlinked with good teaching should, Allen and Simms (2018) argue, be enough to feel an urgency to retain maths teachers.

2.4.2 Comparing England and Sweden

In 2015, the OECD (2015) published multiple reasons to help justify Sweden's TIMSS position. Although students have positive relationships with teachers and studying maths, they find learning environments are not consistently conducive to abilities, and pupils lack challenge which leads to a lack of perseverance in the subject. Like England, maths progress is largely determined by teacher attitudes to achievement and willingness to vary pedagogical approaches (Department for Education, 2016; Andersson and Palm, 2017).

When considering the status of Swedish teachers, the OECD (2015) and Arvidsson *et al.* (2013, cited in Ekstrand, 2015) relate similar findings to that of England, whereby teaching is regarded unattractive due to heavy workload and low salaries. Interestingly, they add that due to principals not trusting teachers enough, there is lack of clarity in roles, and therefore opportunities for constructive feedback are limited. From this, it is understandable that student achievement is low, for teachers' morale directly affects pedagogical performance and thus pupil achievement. Rapp's (2010) argument that principals in Sweden leave teaching and learning responsibilities to teachers further explains the lack of clarity educators face. However, such autonomy is not present in England, as principals are responsible for providing leadership in both these aspects as well as overall performance, and thus teacher stress is high due to the workload that curriculum reform brings (Precey 2015; Busby, 2019; Hazell, 2019).

2.4.3 Comparing England and Singapore

TIMSS questionnaires presented to students based on feelings of belonging and views on engaging teaching were highest in England (10.1% and 10.1%) and lowest in Singapore (9.5% and 9.3%) out of the three countries studied (Mullis *et al.* 2015). However, Fletcher-Wood (2018a) proposes that one should not observe Singapore's maths success as being governed by stressed students and rote learning to the detriment of happiness (Kong *et al.* 2008; Tan and Yates, 2010) without casting a critical eye. He refers to a recent OECD report which points to significant amounts of Singaporean students revealing they are happy at school (87%) (Fletcher-Wood, 2018b, cited in Ng, 2017, p.13) in spite of school and parental pressures which, contrary to expectations, are viewed as sources of motivation. Such positives might be attributed to the high value teachers possess within a culture that prides itself with high achievement, therefore ensuring maths educators are well paid and have mastered the subject before teaching it and entitling them to 100 hours of CPD (higher than both other countries) through which they are free to seek the means to improve pedagogical approaches (NCEE, no date; NCEE, 2016). As a result, Professor Zhao criticises England's choice to implement Singapore's maths curriculum, as he argues there are ample cultural differences that come with maths success which will have progressed by the time England takes them on (Roberts, 2018).

Chapter 3: Methodology

3.1 Secondary Research

Due to the research being cross-cultural in nature, and the complexities of first hand data collection, it was concluded that a desk-based approach should be adopted, meaning secondary data was more appropriate for a wider perspective (Arthur *et al.,* 2012) on the issue of maths pedagogy in the selected countries. Secondary research consists of readily available resources collected from places such as governments and research institutions (Vartanian, 2011) who provide researchers with access to pre-existing data that have been carried out for alternative reasons, but may contain useful data for current research (Webb, 2002; Heaton, 2012; Kumar *et al.,* 2002, cited in Zickermann, 2014).

Collins (2010) advocates a major advantage of secondary research is its ability to provide vast amounts of easily accessible knowledge, which, Mead and Andrews (2009, p.440) add, allows researchers to 'develop new interpretations of existing materials'. By studying and collecting large amounts of varied literature, and taking into account the time spans of the secondary data collected, it was hoped the researcher would come to more informed conclusions than if they were to use one set of data conducted in a short time span, which is common of primary data collection (Upagade and Shende, 2008). That being the aim, it proved disadvantageous in some cases, namely due to the lack of data available for teacher perspectives on mathematical pedagogy in Sweden despite the country's prominence in TIMSS surveys. Blumberg *et al.* (2008, cited in Zickermann, 2014) justify this through stating a possible disadvantage is the research available is insufficient or inaccurate in addressing the needs of current research.

Other positive aspects of analysing secondary data relating to this study, include the ability to study change over time in the form of longitudinal data (Lynn, 2009; Hyman, 1972, cited in Thyer, 2010). Here, the TIMSS mathematical surveys were analysed from 1995-2015 to observe differences in each country's positioning according to their mathematical achievement. The countries' scores would then be analysed against teachers' views to determine whether pedagogical stances should be borrowed from Singapore or Sweden to improve achievement. However, Collins (2010) states that data collected years back is unlikely to match current data. Therefore, data from recent years was sought, and unless older research was of particular relevance to the study, it was avoided in order for the researcher to arrive at an up-to-date conclusion. Such an approach is also adopted by TIMSS who point to the importance of updating their tests' contents to match pupils' current learning experiences (Martin *et al.,* 2019).

3.2 Ethics

When considering ethics, one must ensure research is governed by a set of principles that protect the morality of anybody involved (Hammersley and Traianou, 2012; Miller *et al.,* 2012). Though no participants were directly involved in this study, the researcher took ethics into account by referring to Newman's Code of Practice for Research (2017). Moreover, BERA (2011; 2018)'s emphasis of the rights to confidentiality for research drawn from the internet, and the importance of validity, reliability and credibility were taken into account.

Eynon *et al.* (2017, cited in Fielding *et al.*, 2017, pp.3-6; Woodfield, 2018) note that ethical issues may arise when analysing online data due to the researcher not obtaining informed consent despite studying social aspects (i.e. teacher perspectives). The fact that this is done virtually prevents participants from knowing who is collecting their data, and here, it might be stated that the researcher is to take confidentiality into consideration by avoiding the mention of specific names unless already recorded. Rasmussen (2017, cited in Fielding *et al.*, 2017) argues that these pointers are easily forgotten when there are large amounts of accessible data, and as a result, data quality in terms of the reliability of a publication can be left unconsidered. Therefore, the study aimed to use peer-reviewed sources, which, it was hoped, would mainly derive from trustworthy academic journals (Kelly *et al.,* 2014).

As TIMSS' existing online data was to be used, the manner in which ethical consideration was taken into account by the IEA, who govern the cycles, was looked at. It was discovered that issues such as children's ages were considered prior to handing them paper assessments and all children had to be 9 before being involved (Mullis *et al.,* 2011). More importantly, consideration was given to cultural difference between the three countries and how this could potentially affect the outcomes of the research (Mullis *et al.,* 2007).

3.3 Reliability/ Triangulation

Scaife (2004) believes that it is essential for the reader to feel a sense of trust in what they are reading if it is to be credible, and one way in which this can be achieved is by backing up statements with reliable sources. To strengthen the study's reliability, a mixed methods approach that analysed a range of sources including academic journals and government publications was decided upon. For example, reference was made to the Singaporean ministry of Education and British Department for Education where possible. The study's results took triangulation into consideration (Miles *et al.,* 2014) by including quantitative data through analysing TIMSS tables to obtain positions and scores. Also, a large element of qualitative data in the form of literature

(McQuarrie, 2015), readily available survey data and interviews were used in order to draw out common themes found in the teachers' perspectives.

3.4 Bias

Johnson and Christensen (2012) describe bias as being a threat to the validity of research mainly qualitative in nature, due to selective choosing and recording of information based on personal agenda (Mehra, 2002; Galdas, 2017). The potential of bias is higher in secondary research due to little knowledge of how researchers collected sources (Clough and Nutbrown, 2012), and therefore it was important that a comprehensive literature search was conducted in order to avoid potential bias in the results (Dickinson, 2005). As the researcher is to study trends of three different countries, the possibility of bias may come about. Therefore, Davis-Kean *et al*. (2017, cited in Wyse *et al.*, 2017) find that it is useful to apply a sample weight in order to avoid researching one country more than the others.

Kumar (2019) states that data in newspapers are subject to bias due to the likelihood of subjectivity and a lack of rigor when published. To counteract this bias, reports from trustworthy, broadsheet papers (Timms, 2005) were utilised for data on teacher surveys, and where possible, other sources were looked at to ensure the data accuracy provided in these reports were valid.

3.5 Validity

Validity is concerned with the truthfulness of conclusions generated by a piece of research to yield the best possible outcome (Thyer, 2010; O'Hara *et al.,* 2011). To ensure validity, trustworthy databases such as Taylor and Francis and EBSCO were utilised, from which abstracts were analysed to ensure valid methods and data were present.

Additionally, limitations to the quantitative and qualitative research methods chosen were considered. According to Pring (2001), there appears to be a dominant argument referring to philosophical stances in educational research as having stronger links with psychological and sociological perspectives due to the inconsiderateness portrayed by objective scientific methods to acknowledge humanistic perceptions and feelings (Pring, 2001, pp.31-32). Arthur *et al.* (2012, pp.126-127) argue that there may be low validity in educational research that have insufficient amounts of numerical data, and thus they state secondary research becomes advantageous when one analyses numerical data available to provide context for their predominantly qualitative study. With this in mind, the research contained a mixture of objectivist and subjectivist ontology in the sense that its aim was to pinpoint TIMSS facts quantitatively, and then follow this with reasoning of why such facts were true from qualitative teacher perspectives.

3.6 Generalisability

The generalisability of a study describes the extent to which findings can be replicated within various settings beyond the context it was carried out in (Leung, 2015). Smith (2018) points to a lack of generalisability in qualitative research, and argues that researchers must ensure they consider it in order for the importance of qualitative research to prevail without being overlooked by quantitative data (Hoeber, 2016, cited in Smith, 2018). However, it is important to note that small scale research should not aspire towards statistical generalisability (Barbour, 2012), as its aim is to illuminate and provide answers to issues that may be affecting a given population, perhaps small in number.

3.7 Data Analysis (thematic analysis)

Data analysis is the process of systematically collecting and coding data which helps extract what is meaningful to the research (Wong, 2008). As this research was desk-based, wide amounts of qualitative data were sought through substantial amounts of reading and data extraction. This data was ordered and categorised by thematic analysis into common themes to draw out relevant conclusions pertaining to the research (Braun and Clarke, 2013; Altheide and Schneider, 2017, pp.2-3). A disadvantage of this method would be developing themes that are inconsistent with the research (Holloway and Todres, 2003, cited in Nowell *et al.,* 2017). To avoid such occurrences, the research questions and aims of this study were frequently referred back to.

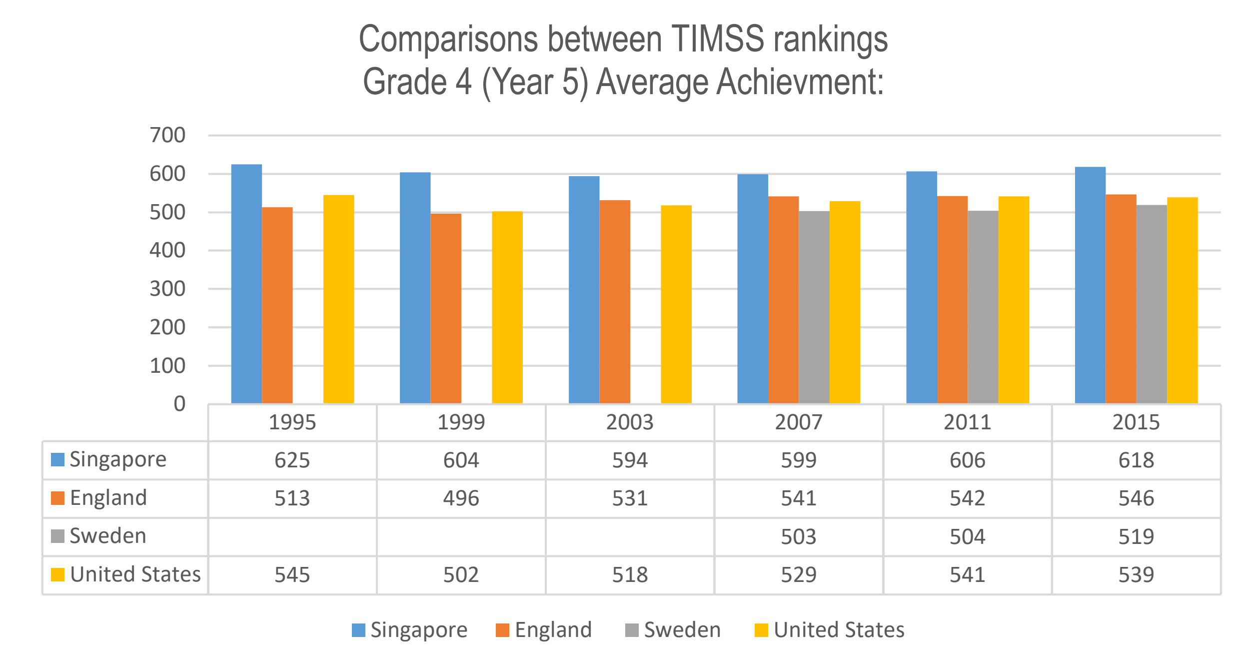
Chapter 4: Results

4.1 How results were collected

As this is a desk based research, the researcher mainly looked to a range of reliable, online sources to help collate results. This included TIMSS mathematical data from Singapore, England and Sweden ranging from 1995-2015, through which patterns of each country's scores would be analysed and compared to determine whether the difference in their positioning over four years was of significance to their mathematical progress. It was also decided that results from the United States would be included as a further comparator to provide the reader with an understanding of how the TIMSS points system works, however as they are not part of the research, this will not be of importance in other parts of the study.

Additionally, a variety of British teachers' views were collected regarding their perspectives on Singaporean and Swedish maths pedagogy, mainly in the form of interview contributions and overall opinions in surveys.

Table 4.2 Summary of results from TIMSS data



	1995	1999	2003	2007	2011	2015
Singapore	625	604	594	599	606	618
England	513	496	531	541	542	546
Sweden				503	504	519
United States	545	502	518	529	541	539

TIMSS scale average = 500

*Note: the 1999 results were a follow-up from 1995. They showed students' progression now that they were in year 9 (IEA, no date).

4.2.1 Description of table of results

To provide an interpretation of the results above, it was necessary to make mention of the international benchmarks used by TIMSS (Appendix 2).

Advanced High Intermediate Low	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)

(TIMSS & PIRLS, 2015)

Singapore

The table shows a clear trend of Singapore achieving highest, indicating that pupils were able to continuously meet requirements in the high and advanced benchmarks (Appendix 2) compared to their counterparts.

Nationally, Singapore's progress showed a decline of 31 points between 1995 and 2003, however there was an increase of 5, 7 and 12 points respectively over the remaining years. Moreover, besides 2007 where they came second to Hong Kong, Singapore has topped the TIMSS tables throughout the TIMSS cycles.

England

There was a consistent trend of increasing scores throughout the years, and England presented itself as meeting requirements within the intermediate and high benchmarks (Appendix 2).

Unlike Singapore, a national increase of 18 points was evident between 1995 and 2003, which was the highest acceleration in points within the countries being studied. Increases in 2007, 2011 and 2015 were very slight, with an addition of 1 and 4 points respectively.

When compared with the other countries, Singapore scored significantly higher throughout the maths cycles, however England's scores were notably higher than Sweden's in all years of Sweden's participation.

Sweden

Though Sweden scored significantly less than both Singapore and England, their meeting of TIMSS mathematical requirements also placed them within the intermediate and high benchmarks (Appendix 2), however their scores were further from the high benchmark than England.

Like England, they showed very little progress between 2007 and 2011, with an added score of 1. Nonetheless, this improved by 15 points in 2015.

Common themes were identified in 6 of the key texts.

Table 4.3: Key themes from British teachers' perspectives found

Countries	**Teacher perspectives against themes**	**Themes**			
		Section 1: Pedagogical approach	**Section 2: Culture's effect on maths delivery**	**Section 3: Pupil progress**	**Section 4: Teacher Attitudes**
Singapore	**For**	Boyd and Ash (2018): **(1.1)** "It's revolutionised my teaching. My subject knowledge is beyond anything it ever was. I have an enthusiasm for maths and I think the depth of rehearsal that I go through for my lessons, I would never, ever have had that	Clapham and Vickers (2018): **(2.1)**" Higher esteem for education, learning. Teachers are respected more. Parents and grandparents have high expectations." (Judy)	Boyd and Ash (2018): **(3.1)**"I went into Year 6 where they never did any Singapore Maths. I was taken aback really about how difficult they found it to express their ideas, and then went into Year 3 today who've had two years of Singapore maths and they knock spots off the Year 6…"(Participant)	Clapham and Vickers (2018): *Textbooks divided opinion amongst teachers:* **(4.1)**" …if you're a teacher who isn't perhaps very mathematically confident…you could use these textbooks as a script…" (Steven) **(4.2)**" Initially we were shocked at the language in

		freedom or time to do it if I didn't have the textbooks." (Rachel) <u>Boyd and Ash (2018):</u> **(1.2)** "I think one of the main differences is that we learn to shut up…so we don't tell them what to think straight away, it's kind of "well what do you think?..." (Participant) **(1.3)** "…one of the ways Singapore maths has changed the way I teach is that you spend a lot of time on one problem, rather than		**(3.2)**"The little girl…she stood up and was saying 'she must have just looked away and 3 balloons had gone'…she's actually not a very confident mathematician, but she's confident enough in front of everybody…whereas I think maybe in the past, that wouldn't have been the case" (Audrey) **(3.3)** "throughout the year, they realised that there's going to be something for them to work out…and they have to share it with each other and talk about it and explain a reason	them, the high level language." (Lillian)

		jumping from problem to problem so you do get that deeper understanding and you don't really leave anyone behind		why…whereas I feel like in the past...they have just thought '…I'll just wait until Miss tells me what we're doing." (Lisa)	
	Against	<u>Clapham and Vickers (2018):</u> **(1.4)** "The first thing they will say is…but I can't do that. I don't just teach maths. I teach maths and English and history…" (Christina) **(1.5)** "It's [mastery] very much a buzz word… it's used in a lot	<u>Clapham and Vickers (2018):</u> **(2.2)**" …you've got to change your whole ethos as a school, your philosophy on teaching maths…and that's a shift on teacher knowledge, teacher expectations, a huge difference in the way the whole staff would	*Negative reference to pupil progress following incorporation of Singaporean maths was not made by teachers.*	<u>Turner (2016):</u> *Survey of 360 maths teachers in the UK.* **(4.3)** Over 49% said that a lack of confidence in their ability to teach maths remains a barrier in adopting mastery methods. **(4.4)** "Children are at risk of underachieving due to a lack of expertise to assess, challenge or question

		of different contexts and slightly different ways…" (Lillian) **(1.6)** "…teachers have been trained to move children through material as fast as they possibly could…whereas now, you get the children to understand very deeply…" (Phyllis) **(1.7)** "There are too many interpretations of what maths mastery is and how to teach it" (Participant)	feel about teaching maths." (Phyllis) **(2.3)** "Knowing what I know about Singaporean culture, I had a concern about the lower level children just being left…we can't replicate what they do in Singapore. I can't have my teachers teaching mathematics in the morning and then going off and doing catch up…there simply aren't the resources." (Sally)		appropriately because of a lack of confidence…" **(4.5)** 90% said they believed there is insufficient funding for training teachers in the mastery method.

		(1.8) "…I also have huge concerns that when we've seen the models from Singapore, we cannot replicate what they have in their country here." (Sally)	**(2.4)**" We did have a lot of discussions on about is this a culture we should be following', we're a creative country…We're a creative school with very confident, articulate children... There's a lot of kind of moral discussion about this…not everything from abroad is good' (Theresa) **(2.5)** "You can't take a Singapore school model and just pick it up and expect it to		

			work fully in an English classroom." (Diane) **(2.6)** "You can't take a model out of Singapore and drop it in the UK…that just doesn't happen…" (Lousie)		
		Section 5: Pedagogical Approach	**Section 6: Culture' effect on maths delivery**	**Section 7: Pupil progress**	**Section 8: Teacher Attitudes**
Sweden	**For**	Priestly, Biesta and Robinson (2013): **(5.1)**" …it's skills for work, skills for life that	Clapham and Vickers (2018): **(6.1)**" I've huge concerns about us	*Positive reference to Swedish pupil progress was not discussed by teachers.*	Bergten and Grevholm (2004): **(8.1)** teachers describe themselves as relaxed and

(links to Sweden)		you are focusing on more…” **(5.2)** “I think my priority is always engaging the kids and producing lessons that they like and can relate to…” (Teacher B) <u>Bergten and Grevholm (2004):</u> **(5.3)** ”Concrete materials help me to explain, and help the pupils to understand.” (Participant)	taking lead from countries with poor human rights records… I’ve said why haven’t we looked at Norway, Sweden, and Denmark…countries who have equally high mathematics results and yet have far better human rights records.” (Sally)		secure in their role, with a general positive attitude. **(8.2)** Good contact with pupils is seen as a necessity to feel secure in the role
	Against	<u>Berg *et al.* (2015):</u>		<u>Bergeten and Grevholm (2004):</u>	*No negative attitudes recorded.*

		(5.4) problem solving is heavily stressed in the new Swedish curriculum and there are certainly a lot of teachers who are not accustomed to teaching problem solving to children **(5.5)** it is not always easy to introduce new contents into mathematical classrooms, even if the teacher was to accept the importance of them.		**(7.1)** Some student teachers stress problems encountered to make students "talk mathematics" with each other…"	

		(5.6) Some teachers considered the level of curriculum goals and national examination as too low in order to find and support high-performing pupils			

4.3.1 Summary of findings

From the onset, it was clear that Singaporean data in terms of teachers' views were widely available compared to Swedish perspectives. A thematic analysis of the data identified four dominant themes.

The first theme involved perspectives on pedagogical approach in the two countries, with Singapore's focus being on mastery. There were mixed views on the effects that mastery maths had on teaching, with one participant stating, "*it's revolutionised my teaching…",* whilst another referred to it as 'a buzz word' being interpreted in numerous ways (Table 4.3; 1+5). Links made to Swedish data referred to the importance of what one participant called "skills for work…" (Table 4.3; 5), whilst others notably mentioned elements that linked to curriculum changes, Singaporean mastery and the positives and negatives of these.

The second emerging theme was that of cultural effects on maths delivery. From the research, it was evident that conflicting views outweighed the positives greatly. Main concerns included the difficulty replicating another country's curriculum would hold (Table 4.3; 2), whilst one teacher, in reference to Singapore, noted a "higher esteem for education… and teachers are respected more."

Thirdly, pupil progress against curriculum change was considered by teachers, and findings were predominantly positive (Table 4.3; 3) with no negative effects on progress found as a result of Singaporean implementation in England's schools. The opposite was true of Swedish data (see Table 4.3; 7).

The final theme that emerged related to teachers' attitudes towards changes within the curriculum that linked to the adoption of Singaporean and Swedish pedagogy. A common barrier considered by participants was the lacking of confidence in teachers partly due to insufficient training opportunities. One participant expressed this, stating, "Children are at risk of underachieving due to a lack of expertise to assess, challenge or question appropriately because of a lack of confidence within teachers." No negative perspectives were discovered in Swedish data (4.3; 8).

The results overall show a mixed picture with a range of views to base the discussion section on.

Chapter 5: Discussion

In his study of the international policy borrowing phenomenon, Alexander (2008) highlights England's on-going drive to obtain standards similar to high achieving peers across borders due to the national decline that is gradually occurring as a result of teaching methods used in schools. This directly coincides with Schmidt *et al.* (2002)'s view that the process of emulation revolves around adopting successful ideas which are an alternative to approaches that may not be working in the current system. They specifically mention the fact that borrowing pedagogical ideas should not be a process of emulating a single country, as the cultural and social aspects of a nation in terms of its teacher and pupil expectations are crucial to their mathematical achievement and thus their international league positions (Alexander, 2008). This is something, it might be argued, which has not been taken into enough consideration by policymakers, who are more interested in a top down approach which ignores teachers' beliefs and pedagogical practices.

The themes presented in the results section will be interlinked with the research questions in an attempt to reach some conclusions.

5.1 Culture

When considering TIMSS mathematical results and teacher perspectives collected**,** it is worth noting that Singapore receives the most attention due to its ability to consistently top the TIMSS survey (Appendix 1), and also due to the popularity of its mastery approach, which is referred to by teachers in abundance. Despite Schmidt *et al.* (2002) pointing out that borrowing policies should involve emulating good practice, it is clear in this research that there is a strong commitment towards looking at

Singaporean pedagogy compared to Swedish. This is evident in the differing number of perspectives found for each country (Table 4.3), and some teachers do not hesitate to comment on the hasty conclusions they feel policy makers are coming to (Roberts, 2018) in terms of disregarding the creativity their curriculum has. One participant's statement about cultural differences mirrors Roberts (2018)'s argument through the statement, "…we're a creative country…we're a creative school…not everything from abroad is good" (Table 4.3; 2.4). This statement provides a direct argument against the examining and test-based culture ingrained in Singaporean values (Lim, 2012, cited in Crisp, 2013), as it is in contradiction with England's objective to move away from an assessment driven culture (George, 2019; Richardson, 2019; Weale, 2019).

In a DfE (2014) statement, Oates provides a compelling argument against the use of levels in the British education system, which he reveals is one of the main reasons why mastery is welcomed as an alternative to the speedy acceleration of progression through levels, which, he argues, is a waste of teaching time if students are not retaining initial knowledge taught in enough depth (Department for Education, 2013; Maths No Problem!, 2019). Further to this view, one participant expresses the different approach Singapore has towards education, in that there is "higher esteem for education and learning…parents and grandparents have higher expectations" (Table 4.3; 2.1), which is yet another reference to the variance in culture and level of educational involvement children are acquainted with outside of school (Sharma, 2015). In context though, this was seen as a positive aspect of Singaporean maths achievement, and therefore interlinked with Chia and Toh (2012, cited in Crisp, 2013)'s mention of the hardworking culture and value of education that the Confucian tradition held. Through this statement, it was inferred that the participant regarded the overall approach to maths, in and outside school, as important to pupil motivation and progress, due to a large percentage of the population in England expressing increasing amounts of anxiety towards it (Royal Statistical Society, 1995; Williams, 2008, p.1; Brian, 2012; Garner, 2012; O'Leary *et al.* 2017). It also suggested parents were an important aspect of pupils' progression in maths, and this matched two important aspects in the literature review, one being that East Asian children living in the west achieve higher results in maths, proving that home culture was a causal factor (Jerrim, 2015, pp.311-329) of the high TIMSS results in Singapore (Table 4.2). Secondly, teachers were not the only ones accountable for England's failure to match higher achieving nations (Gowers, 2016), and this was summed up by a teacher who acknowledged her feelings towards borrowing mastery through stating, "…you've got to change your whole ethos as a school, your philosophy on teaching maths…a huge difference in the way staff would feel about teaching maths." (Table 4.3; 2.2).

One participant in particular expressed concerns around Singaporean culture, and questioned England's persistence in imitating systems she saw as having less regard for human rights. "Knowing what I know about Singaporean culture, I had a concern about the lower level children just being left…we can't replicate what they do in Singapore" (Table 4.3; 2.3). She continued by expressing her huge concern around "us taking lead from countries with poor human rights records", and questioned why places such as Sweden "who have equally high maths results and yet far better human rights records" (Table 4.3; 6.1) were not being taken from as willingly.

When analysing the tables in Appendix 3, it is apparent that the UK scores significantly lower than Sweden when it comes to child well-being (Tables 1, 1.2 and 4). The argument therefore would be whether decisions to follow countries that top TIMSS are followed to the detriment of a child's well-being for the purpose of international competition**.** The participant's reference to Sweden having "equally high mathematical results" leads to the comparison of their TIMSS scores with that of England's (Table 4.2), whereby it is discovered that Sweden scores closer to the intermediate benchmark on all occasions, whilst England produce results that place them in closer proximity to the high benchmark. Sweden's lower scores should not deter us from acknowledging the fact that both countries possess similar overall objectives with regard to the importance of producing a mathematically skilful workforce (Department for Education, 2014), something that a large percentage of the British population are lacking in (Department for Business and Innovations and Skills, 2012; Hodgen *et al.,* 2018; National numeracy, 2018). When considering the Swedish curriculum, one participant mentions, "…it's skills for work, skills for life that you are focusing on more…" This statement, along with proof of good human rights records, should spark interest in Sweden's curriculum, as it may provide alternative pedagogical ideas that focus on producing a skilful workforce, regardless of their positioning on international tables. Furthermore, such ideas may prove beneficial to the British system's fervent aim to reduce both accountability measures and narrowing of the curriculum, as there is a reduced focus on maths test scores that do not necessarily represent increased understanding (Hutchings, 2014; Bloom, 2017).

The argument above therefore implies that culture is a crucial factor in deciding whether certain pedagogical methods will work successfully in one country as they do in the country of origin, as the adoption of a curriculum requires holistic overview of both value and culture. The next section therefore will discuss the views of teachers on specific teaching approaches and how they have worked for their individual classes and selves.

5.2 Pedagogical Approaches

Upon looking at England's maths positioning in TIMSS over the years (Appendix 1), it is evident that all scores are between the intermediate and high benchmark, with a closer proximity to the high benchmark (Appendix 2, Tables 2+3). This leads one to question the need for competitiveness and pedagogical change, thus coinciding with Rudock and Sainsbury (2008)'s research that acknowledges England's consistent ability to score respectably in international tables. On the other hand, Singapore consistently produce scores between the high and advanced benchmarks, with a greater tendency to score closer to the advanced (Appendix 2; 4). When examining the descriptive summaries of these benchmarks, it is observed that students under both are able to 'apply their knowledge and understanding to solve problems', with the difference in advanced achievement being their ability to 'explain reasoning' (Appendix 2, Tables 2+3).

Part of the reason mastery has been developed is to shift from teacher-led instruction to a more child focused approach, and one participant puts forth their view with a direct link to this shift by saying, "I think one of the differences is that we learn to shut up…so we don't tell them what to think straight away, it's kind of "well what do you think?" (Table 4.3; 1.2), whereas initially it was, as another participant notes, "…they have to share it with each other and talk about it and explain a reason why…whereas I feel like in the past, they have thought…"I'll just wait for Miss to tell me what we're doing."(Table 4.3; 3.3). Here, it is clear that British teachers view the inclusion of reasoning as positive to the development of mathematical understanding, and this complements the NIE (2018)'s prescription that teachers are to assist children to make sense of and reason with their maths rather than being dispensers of knowledge.

The act of teaching multiple mathematical concepts with little regard for in-depth understanding is an aspect England's maths teachers have been criticised for implementing (Schleicher, 2016, cited in ACME, 2016). However, Schleicher's view that maths is being taught in a complicated manner disputes the concern teachers have, in which they express that frequently adopting new initiatives are difficult to quickly adapt to; "…but I can't do that. I don't just teach maths. I teach maths and English and history…" (Section 4.3; 1.4). Another states, "…teachers have been trained to move children through material as fast as they possibly could… whereas now, you get children to understand very deeply" (Table 4.3; 1.6). This shift to deepening understanding provides teachers with a reason to produce pedagogy that encourages higher achieving pupils to learn at greater depth (OECD, 2010), something which is barely considered when the aim is to progress through levels rapidly. However, one participant disputes this by saying, "it is not always easy to introduce new content into mathematical classrooms, even if the teacher was to accept the importance of them" (Table 4.3; 5.5). It could be argued therefore, that the DfE (2014) are adopting alternative curriculum initiatives from high achieving countries to rectify underlying issues such as their handling of mathematical assessment. When viewed in this way, some teachers express their appreciation of the mastery initiative through revealing that the introduction of resources and schemes such as mastery textbooks may help overcome the lack of confidence British teachers have (Garner, 2012) (see Table 4.3; 4.1). Nonetheless, negative perspectives express confusion (Table 4.3; 4.2, 4.3 and 4.4), describing mastery as being a contrasting initiative with “many interpretations”, resulting in an each-to-their-own manner in teaching maths. From this, it might be inferred that those who accept the textbooks see it as a guide to the new initiative imposed on them by governmental pressures (Cuban, 1993, cited in Bernack-Schuler *et al.,* 2015), and therefore constantly making alterations to the curriculum ignores prevalent teacher confidence issues.

Moreover, when analysing curriculum changes between England and Singapore, the use of ICT in maths is something already established in England, but has more recently been adopted in Singapore (Ministry of Education, 2012, p.19-21; Department for Education, 2013). This shows that whilst Singapore rapidly progress in their approach to teaching maths, England is left implementing what has already been mastered in Singapore, which is in agreement with professor Zhao’s hypothesis that Singapore would move on whilst those imitating them would be playing catch-up (Roberts, 2018).

When considering the difference between TIMSS’ intermediate and high benchmarks (Appendix 2), Sweden also demonstrates its attempt to catch up with counterparts. For example, one teacher expresses that “problem solving is heavily stressed in the new Swedish curriculum… not a lot of teachers are accustomed to teaching problem solving to children” (Table 4.3; 5.4). Failure to mention problem solving in the intermediate benchmark perhaps shows why Sweden edge closer to this benchmark, hence their prime focus being on oral mathematics in an attempt to improve this aspect (Hanson, 2012; Seaberg, 2015; Brating and Ostermon, 2017).

5.3: Teacher experiences, attitudes and pupil progress

Hargreaves and Fullan (2012) agree that policy borrowing to change teaching approaches is less beneficial to a good education than the retention of teachers who can initiate quality learning. Being aware of the different formalities of new resources requires consideration and reorientation of teachers' professional development experiences, as it is likely that skill sets will be challenged. Results collected found that "90% of teachers believed there is insufficient funding for the mastery method" (Table 4.3; 4.5) and "there simply aren't the resources" (2.3). The lack of funding ordeal, alongside having to familiarise oneself with new pedagogical approaches, presents itself as a reason for the low job satisfaction British teachers have (Department for Education, 2016). Moreover, having to accept an increase in workload without sufficient amounts of CPD can result in, as one teacher put it, pupils "underachieving due to a lack of expertise to assess, challenge or question appropriately…" (Table 4.3; 4.4) on the teachers' part. Other teachers however, had more positive opinions regarding pupil progress following the adoption of Singaporean mastery methods through stating, "Concrete materials help me to explain, and help the pupils to understand" (Table 4.3; 5.3). Interestingly, this comment was made by a teacher in Sweden, and it, alongside point 5.4 (Table 4.3), show Sweden's attempt to address the fact that "some teachers considered the level of curriculum goals as too low in order to find and support high achieving pupils" (Table 4.3; 5.6). This was also an issue highlighted by the OECD (2015) who, in an attempt to explain Sweden's TIMSS ranking, discovered that learning environments provided pupils with insufficient challenge, hence lower levels of motivation. This then, along with other views supporting the mastery method (Table 4.3; 3.1, 3.2), and the lack of negative perspectives relating to how pupils benefit from it (section 7: Against), illustrates the beneficial effects teachers believe it has on pupil motivation and progress. In hindsight, it is hoped that witnessing such progress motivates teachers, as it is through their willingness to remain and adapt to change that determines pupils' attainment and motivation to succeed mathematically (Carnoy *et al.,* 2009; Department for Education, 2016; Andersson and Palm, 2017; Allen and Simms, 2018; Coughlan, 2018).

When analysing Swedish data collected, it is apparent from one study that "teachers describe themselves as relaxed and secure in their role, with a general positive attitude" (Table 4.3; 8.1). One teacher describes their priority as "always engaging the kids and producing lessons they like and can relate to" (Table 4.3; 5.2). Arvidsson *et al.* (2013, cited in Ekstrand, 2015)'s argument regarding the lack of head teacher interference leads to the belief that educator autonomy is greater in Sweden, allowing teachers to produce maths lessons directed by pupil needs more so than in England. It might be inferred that it is due to less involvement of Swedish head teachers on curriculum reform compared to England that frees Swedish teachers from constant performance scrutiny (Precey, 2015; Busby, 2019; Hazell, 2019). The points above therefore suggest levels of trust and teacher autonomy can determine the attitude and quality of teaching presented to students.

A separate argument by Arvidsson *et al.* (2013, cited in Ekstrand, 2015) discovers Swedish teachers have limited opportunities for constructive feedback, and therefore lack clarity in their roles due to little headteacher involvement. This is in contrast with the 100 hours of CPD Singaporean teachers are entitled to during the year, in which they have the freedom to develop pedagogical approaches as necessary (NCEE, no date; NCEE, 2016), despite them having mastered the subject during training. Again, this returns to the cultural aspects of the education systems, and how high in status each nation regards teachers' development.

In effect, it seems as though the current choice is between two, either to have more autonomy with less CPD like Sweden, and therefore minimal progression in terms of furthering pedagogical approaches, or, as with the current situation of borrowing mastery, to have less autonomy and more CPD to inform and help teachers adapt to changes, thus maintaining a high position in TIMSS.

Chapter 6: Conclusion

6.1 Concluding statement

This study has attempted to decipher some of the issues behind England's low mathematical progress, and has discovered that the concept of borrowing policies from abroad involves much more than the emulation of pedagogical ideas. It has also discovered that when compared internationally, England are only viewed as being low in the TIMSS tables due to expectations upon themselves to match pedagogy true of the highest scoring nations, something that has caused them to direct less attention towards countries such as Sweden who share their values and overall objectives for maths progression.

Moreover, it acknowledges that the process of borrowing and implementation is slow, hence the minor increase in TIMSS scores over each of the 4 years (Table 4.2). Some researchers say that minor increases to scores do not indicate sufficient progress (NFER, 2016), and therefore, after all this borrowing from East Asia, it questions why England is unable to improve scores and come closer to Singapore. Additionally, the argument that curriculums are constantly progressing questions the worthiness of competition, as once one country has accomplished something that another is successful at, they would have to then catch up with the next thing.

Following the research collated, it seems appropriate to suggest that for England's maths teaching to prosper, the concept of borrowing international pedagogy which is deeply rooted within the system (Alexander, 2008) should continue. However, this should not be based on countries' TIMSS positions, but on the level that British pupils' stand at different points in time, and how the particular issue faced can be rectified by successful practice that another country has used to solve a similar issue. The borrowing of single aspects of pedagogy rather than the emulation of a whole curriculum helps eliminate the cultural factor that is so difficult to adopt from countries that possess differing values towards teachers, and more specifically, maths. Schleicher (2018) sums this up by stating that such borrowing is seen to work effectively in improving students' mathematical performance rates without the alteration of teachers or culture.

6.2 Limitations and weaknesses

Due to time constraints, some difficulty was faced when searching for Swedish data that matched the research question, hence the imbalance in Singaporean and Swedish teacher data and the possibility of less insight into Swedish mathematical pedagogy. However, this did not limit the ability to reach beneficial conclusions, one of which regards both Sweden and England as showing efforts to climb the TIMSS benchmarks by implementing practice that will eventually lead them to the advanced benchmark. Due to Singapore being top, it might appear as though they have no choice but to emulate them to improve maths attainment. This could be seen as a flaw of TIMSS, who, instead of raising Singapore in high esteem due to their position, should acknowledge and report what England and Sweden do that are proving beneficial to their schools in order for countries to be more open towards borrowing policies from nations lower down in TIMSS data, who hold the same values and aims as the country looking to borrow new ideas.

6.3 Recommendations for further research

The study portrays that though there are cultural implications when borrowing pedagogical ideas, teachers are increasingly surprised at the benefit that initiatives such as mastery are having on pupil progress. Further research on this subject might question whether SEN pupils are taken into account when borrowing such policies, and whether they are seen to work equally well for them.

References:

Adams, R., Weale, S., Bengtsson, H. and Carell, S. (2016) 'UK schools fail to climb international league table', *The Guardian,* 6 December. Available at: https://www.theguardian.com/education/2016/dec/06/english-schools-core-subject-test-results-international-oecd-pisa (Accessed: 6 May 2019)

Advisory Committee on Mathematics Education (ACME) (2016) *Professional learning for all teachers of mathematics.* Available at: http://www.acme-uk.org/media/36491/professional%20learning%20for%20all%20teachers%20of%20mathematics%20-%20final.pdf (Accessed: 7 April 2019)

Alexander, R. (2008) *Essays on pedagogy.* Oxon: Routledge

Allen, R. and Simms, S. (2018) *How do shortages of maths teachers affect the within-school allocation of maths teachers to pupils?* Available at: https://www.nuffieldfoundation.org/sites/default/files/files/Within-school%20allocations%20of%20maths%20teachers%20to%20pupils_v_FINAL.pdf (Accessed: 8 April 2019)

Altheide, D. (2012) 'The SAGE Encyclopaedia of Qualitative Research methods', in Given L. (ed.) *Ethnographic Content Analysis.* Thousand Oaks: SAGE Publications, Inc.

Altheide, D.L., Schneider, C.J. (2017) *Process of Qualitative Document Analysis* Available at: http://methods.sagepub.com/base/download/BookChapter/qualitative-media-analysis-2e/i243.xml (Accessed 20 October 2018)

Andersson, C. and Palm, T. (2017) 'Characteristics of improved formative assessment practice', *Education Inquiry,* 8 (2), pp.104-122

Arthur, J., Waring, M., Coe, R. and Hedges, LV. (2012) *Research methodologies and Methodologies in Education* London: SAGE Publications Ltd.

Arthur, J., Waring, M., Coe, R. and Hedges, LV. (2012) *Research methodologies and Methodologies in Education* London: SAGE Publications Ltd.

Barbour, R.S. (2012) 'Checklists for improving vigour in Qualitative research: a case of the tail wagging the dog?', *The BMJ,* 322(7294), pp. 1115–1117

Berg, B., Hemmi, K. and Karlberg, M. (2015) 'Support or restriction: Swedish Primary School Teachers' Views on Mathematics Curriculum Reform' in Bernack-Schuler, C., Erens, R., Eichler, A. and Leuders. (eds.) *Views and Beliefs in Mathematics Education: Results of the 19th MAVI Conference.* Springer Spektrum.

Bergten, C. and Grevholm, B. (2004) 'The didactic divide and the education of teachers of mathematics in Sweden', *Nordic Studies in Mathematics Education,* 9 (2), pp.123-144.

Bernack-Schuler, C., Erens, R., Eichler, A. and Leuders, T. (eds.) (2015) *Views and Beliefs in Mathematics Education.* Springer Spektrum.

Boston College (1997) *TIMSS Highlights from the Primary Grades.* Available at: https://timss.bc.edu/timss1995i/TIMSSPDF/P1HiLite.pdf (Accessed: 21 April 2019)

Boyd, P. and Ash, A. (2018) 'Teachers framing exploratory learning within a text-book based Singapore Maths mastery approach', *Teacher Education Advancement Network Journal,* 10 (1), pp. 62-73

Boylan, M. (2016) 'South Asian - or 'Shanghai' – mastery maths, explained', *SCHOOLS WEEK,* 13 July. Available at: https://schoolsweek.co.uk/what-is-south-asian-mastery-maths/ (Accessed: 2 December 2018)

Brating, K. and Osterman, T. (2017) *John Dewey and mathematics education in Sweden.* Available at: https://uu.diva-portal.org/smash/get/diva2:1141560/FULLTEXT01.pdf (Accessed: 7 April 2019)

Braun, V. and Clarke, V. (2013) *Successful Qualitative Research: a practical guide for beginners.* London: SAGE Publications Ltd.

Brian, K. (2012) 'Maths Anxiety: The numbers are mounting', *The Guardian,* 30 April. Available at: https://www.theguardian.com/education/2012/apr/30/maths-anxiety-school-support (Accessed: 16 November 2018)

British Educational Research Association (BERA) (2018) *Ethical Guidelines For Educational Research.*4th edn. Available at: https://www.bera.ac.uk/wp-content/uploads/2018/06/BERA-Ethical-Guidelines-for-Educational-Research_4thEdn_2018.pdf?noredirect=1 (Accessed: 16 April 2019)

Busby, M. (2019) 'Teachers experience more stress than other workers, study shows', *The Guardian,* 25 February. Available at: https://www.theguardian.com/education/2019/feb/25/teachers-experience-more-stress-than-other-workers-study-shows (Accessed: 10 April 2019).

Carnoy, M., Brodziak, I., Luschei, T., Beteille, T. and Loyalka, P. (2009) *TEACHER EDUCATION AND DEVELOPMENT STUDY IN MATHEMATICS (TEDS-M).* Available at: https://www.iea.nl/fileadmin/user_upload/Publications/Electronic_versions/TEDS-M_Cost_Study.pdf (Accessed: 8 April 2019)

Cartwright, A. (2017) *Five things you should know about Singapore Maths.* Available at: https://www.ypo.co.uk/news-and-events/blog/five-things-you-should-know-about-singapore-maths (Accessed: 25 November 2018)

Clapham, A. and Vickers, R. (2018) 'Neither a borrower nor a lender be: exploring 'teaching for mastery' policy borrowing', *Oxford Review of Education,* 44 (6), pp.787-805

Collins, H. (2010) *CREATIVE RESEARCH: The theory and practice of research for the creative industries.* London: AVA Publishing SA.

Coughlan, S. (2016) 'Singapore tops global education rankings', *BBC News,* 29 November. Available at: https://www.bbc.co.uk/news/education-38131731 (Accessed: 16 November 2018)

Coughlan, S. (2018) 'England's schools face 'severe' teacher shortage', *BBC News,* 30 August. Available at: https://www.bbc.co.uk/news/education-45341734 (Accessed: 8 April 2019)

Davis Kean, P.E. and Jager, J. (2017) '*Using Secondary Data Analysis',* in Wyse, D., Selwyn, N., Smith, E. and Suter, L.E. (eds.) *The BERA/ SAGE Handbook of Educational Research,* London: SAGE Publications Ltd.

Deng, Z. and Gopinathan, S. (2016) 'PISA and high-performing education systems: explaining Singapore's education success', *Comparative Education,* 52 (4), pp. 449-472

Department for Education (2012) *Review of the National Curriculum in England: What can we learn from the English, mathematics and science curricula of high-performing jurisdictions?* Available at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/184064/DFE-RR178.pdf (Accessed: 6 April 2019)

Department for Education (2013) *Mathematics programmes of study: key stages 1 and 2.* Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/335158/PRIMARY_national_curriculum_-_Mathematics_220714.pdf (Accessed: 6 April 2019)

Department for Education (2016) *Trends in Maths and Science Study (TIMSS): National Report for England.* Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/572850/TIMSS_2015_England_Report_FINAL_for_govuk_-_reformatted.pdf (Accessed: 7 April 2019)

Dickson, R. (2005) 'Systematic reviews', in Hamer, S. and Collinson, G. (eds.) *Achieving Evidence-based Practice.* 2nd edn. London: Elsevier Ltd.

Drury, H. (2016) *The UK, Singapore and Shanghai: what's the same and what's different?* Available at: https://www.mathematicsmastery.org/the-uk-singapore-and-shanghai-whats-the-same-and-whats-different/ (Accessed: 25 November 2018)

Ekstrand, B. (2015) 'What it takes to keep children in school: A research review', *Educational Review,* 67 (4), pp.459-482.

Eriksson, K., Helenius, O. and Ryve, A. (2018) 'Using TIMSS items to evaluate the effectiveness of different instructional practices', *Instructional Science,* 47 (1), pp.1-18

Fielding, N., Raymond, L., and Blank, G. (eds.) (2017) *The SAGE Handbook of Online Research Methods* Available at: http://www.worldcat.org/title/sage-handbook-of-online-research-methods/oclc/967704782/viewport (Accessed: 21 October 2018).

Fletcher-Wood, H. (2018a) *Education in Singapore: 2) Stressed students?* Available at: https://improvingteaching.co.uk/2018/01/30/education-in-singapore-2-stressed-students/ (Accessed: 10 April 2019).

Fletcher-Wood, H. (2018b) *Education in Singapore: 3) Why do students like school?* Available at: https://improvingteaching.co.uk/2018/02/01/education-in-singapore-3-why-do-students-like-school/ (Accessed: 10 April 2019).

Galdas, P. (2017) 'Revisiting Bias in Qualitative Research: Reflections on Its Relationships With Funding and Impact', *International Journal of Qualitative Methods,* 16, pp. 1-2.

Garner, R. (2012) 'Almost 50 per cent of adults can't do basic maths (that means half)', *The Independent,* 2 March. Available at: https://www.independent.co.uk/news/education/education-news/almost-50-per-cent-of-adults-cant-do-basic-maths-that-means-half-7469119.html (Accessed: 16 November 2018)

Gorard, S., See, B. and Morris, R. (2016) *Teacher Review of effective teaching approaches in primary schools.* Available at: http://dro.dur.ac.uk/20111/1/20111.pdf (Accessed: 1 April 2019)

Gowers, T. (2016) 'Maths isn't the problem- the way it's taught is', *The Guardian,* 11 March. Available at:

https://www.theguardian.com/commentisfree/2016/mar/11/maths-isnt-problem-curriculum-lacking-imagination (Accessed: 16 November 2018)

Greany, T., Barnes, I., Mostafa, T., Pensiero, N. and Swensson, C. (2016) *Trends in Maths and Science Study (TIMSS): National Report for England.* Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/572850/TIMSS_2015_England_Report_FINAL_for_govuk_-_reformatted.pdf (Accessed: 16 November 2018)

Guan, T.E., Lim, S.K., Kin, H.W. and Lam, T.T. (2017) *Preparing Mathematics Teachers in Singapore: The Issue of Mathematics Content Knowledge.* Available at: http://math.nie.edu.sg/wkho/Research/My%20publications/Math%20Education/Preparing%20mathematics%20teachers%20in%20Singapore%20Mathematics%20Content%20Knowledge%20amended.pdf (Accessed: 25 November 2018)

Gurney-Read, J. (2016) 'Revealed: World pupil rankings in science and maths – TIMSS results in full', *The Telegraph,* 2 April. Available at: https://www.telegraph.co.uk/education/2016/11/29/revealed-world-pupil-rankings-science-maths-timss-results/ (Accessed: 2 April 2019)

Hammersley, M. and Traianou, A. (2012) *Ethics in Qualitative Research.* London: SAGE Publications Ltd.

Hazell, W. (2019) 'Unrealistic expectations' heap stress on teachers, says bishop', *TES news,* 7 February. Available at: https://www.tes.com/news/unrealistic-expectations-heap-stress-teachers-says-bishop (Accessed: 10 April 2019).

Heaton, J. (2011) *Reworking Qualitative Data.* London: SAGE Publications Ltd.

Hill, C. (1997) *Largest International Study of Student Achievement Ever Taken: Countries rankings for 3rd and 4th grades to be released.* Available at: https://timssandpirls.bc.edu/timss1995i/Presspop1.html (Accessed: 16 November 2018)

House of Commons Public Accounts Committee (2008-09) *Mathematics performance in primary schools: Getting the best results.* Available at: https://publications.parliament.uk/pa/cm200809/cmselect/cmpubacc/44/44.pdf (Accessed: 14 November 2018)

http://designresearchtechniques.com/casestudies/secondary-research/

Jenkins, S. (2016) 'Our fixation with maths doesn't add up', *The Guardian,* 10 March. Available at: https://www.theguardian.com/commentisfree/2016/mar/10/fixation-maths-doesnt-add-up-targets (Accessed: 16 November 2018)

Jerrim, J. (2015) 'Why do East Asian children perform so well in PISA? An investigation of West-born children of East Asian decent', *Oxford Review of Education,* 41 (3), pp.310-333

Johnson, B. and Christensen, L. (2012) *Educational Research: Quantitative, Qualitative, and Mixed Approaches.* 4th edn. London: SAGE Publications Ltd.

Kelly, J., Sadaeghieh, T. and Adeli, K. (2014) 'Peer Review in Scientific Publications: Benefits, Critiques , & Survival Guide', *The Journal of the International Federation of Clinic of Chemistry and Laboratory Medicine,* 25 (3), pp.227-243

Kong, L.S., Boon, C., Fredrisken, B. and Peng, T.J. (eds.) (2008) *Toward a Better Future: Education and Training for Economic Development in Singapore since 1965.* Washington: The International Bank for Reconstruction and Development.

Kuczera, M., Field, S. and Windisch, H.C. (2016) *Building Skills for All: A Review of England.* Available at: file:///C:/Users/User/Downloads/building-skills-for-all-review-of-england%20(1).pdf (Accessed: 14 November 2018)

Kumar, R. (2019) *Research Methodology A step-by-step guide for beginners.* 5th edn. London: SAGE Publications Ltd.

Leung, L. (2015) 'Validity, reliability, and generalizability in qualitative research', *Journal of Family Medicine and Primary Care,* 4 (3), pp. 324-327.

Lynn, P. (ed.) (2009) *Methodology of Longitudinal Surveys.* Chichister: John Wiley & Sons Ltd.

Martin, M., Mullis, I. and Hooper, M. (2019) *Methods and Procedures in PIRLS 2016.* Available at: https://timssandpirls.bc.edu/publications/pirls/2016-methods/P16_Methods_and_Procedures.pdf (Accessed: 15 April 2019)

McQuarrie, E.F. (2015) the Market Research Toolbox: A Concise Guide for Beginners. 4th edn. London: SAGE Publications Ltd.

Mead, R. and Andrews, T.G. (2009) *International Management: Culture and Beyond.* 4th edn. Chichester: John Wiley & Sons Ltd.

Mehra, B. (2002) 'Bias in Qualitative Research: Voices From an Online Classroom', *The Qualitative Report,* 7 (1), pp.1-19.

Merttens, R. (2015) 'Why are we blindly following the Chinese approach to teaching maths?', *The Guardian,* 10 February. Available at: https://www.theguardian.com/teacher-network/2015/feb/10/chinese-teaching-primary-maths (Accessed: 25 November 2018)

Miles, M.B., Huberman, A.M. and Saldana. J. (2014) *Qualitative Data Analysis.* 3rd edn. London: SAGE Publications Ltd.

Miller, T., Birch. M., Mauthner, M. and Jessop, J. (eds.) (2012) *Ethics in Qualitative Research.* 2nd edn. London: SAGE Publications Ltd.

Ministry of Education (Singapore) (2013) *Mathematics Syllabus Primary One to Six.* Available at: https://www.moe.gov.sg/docs/default-source/document/education/syllabuses/sciences/files/mathematics_syllabus_primary_1_to_6.pdf (Accessed: 1 April 2019)

Ministry of Education Singapore (2012) *MATHEMATICS SYLLABUS Primary One to Five.* Available at: https://www.moe.gov.sg/docs/default-source/document/education/syllabuses/sciences/files/primary_mathematics_syllabus_pri1_to_pri5.pdf (Accessed: 3 April 2019)

Ministry of Education Singapore (2014) *Mastering the Subjects & Loving the Experience: Singapore Students' Strengths in Maths and Science Affirmed.* Available at: https://www.moe.gov.sg/news/press-releases/mastering-the-subjects-and-loving-the-experience--singapore-students-strengths-in-maths-and-science-affirmed (Accessed: 6 Aril 2019)

Mullis, I., Martin, M., Pierre,F. and Hooper, M. (2015) *TIMSS 2015 International Results in Mathematics.* Available at: http://timssandpirls.bc.edu/timss2015/international-results/wp-content/uploads/filebase/full%20pdfs/T15-International-Results-in-Mathematics-Grade-4.pdf (Accessed: 10 April 2019).

Mullis, I., Martin, M.O., Foy, P. and Arora, A. (2011) *TIMSS 2011 International Results in Mathematics.* Available at: https://timssandpirls.bc.edu/timss2011/downloads/T11_IR_Mathematics_FullBook.pdf (Accessed: 16 April 2019)

Mullis, I., Martin, M.O., Olson, J.F., Berger, D.R., Milne, D. and Stanco, G.M. (2007) *TIMSS 2007 Encyclopaedia: A Guide to Mathematics and Science Education Around the World.* Available at: https://timss.bc.edu/timss2007/pdf/t07_enc_v1.pdf (Accessed: 16 April 2019)

National Center on Education and the Economy (NCEE) (no date) *Singapore: Teacher Principal and Quality.* Available at: http://ncee.org/what-we-do/center-on-international-education-benchmarking/top-performing-countries/singapore-overview-2/singapore-teacher-and-principal-quality/ (Accessed: 8 April 2019)

National Centre for Education Statistics (2003) *Trends in International Mathematics and Science Study (TIMSS).* Available at: https://nces.ed.gov/timss/timss03tables.asp?Quest=1&Figure=1 (Accessed: 21 April 2019)

National Centre for Education Statistics (2003) *Trends in International Mathematics and Science Study (TIMSS).* Available at: https://nces.ed.gov/timss/table07_1.asp (Accessed: 21 April 2019)

National Centre for Education Statistics (2003) *Trends in International Mathematics and Science Study (TIMSS).* Available at: https://nces.ed.gov/timss/table11_2.asp (Accessed: 21 April 2019)

National Centre for Education Statistics (2003) *Trends in International Mathematics and Science Study (TIMSS).* Available at: https://nces.ed.gov/timss/timss2015/timss2015_table01.asp (Accessed: 21 April 2019)

National Centre for Excellence in the Teaching of Mathematics (NCETM) (2014) *Mastery approaches to mathematics and the new national curriculum.* Available at: https://www.ncetm.org.uk/public/files/19990433/Developing_mastery_in_mathematics_october_2014.pdf (Accessed: 6 April 2019)

National Centre on Education (NCEE) (2016) *EMPOWERED EDUCATORS: How high-performing systems shape teaching quality around the world- SINGAPORE: A TEACHING MODEL FOR THE 21ST CENTURY.* Available at: http://ncee.org/wp-content/uploads/2017/02/SingaporeCountryBrief.pdf (Accessed: 8 April 2019)

National Council of Teachers of Mathematics (2018) *A Teacher's Guide to Reasoning and Sense-making.* Available at: https://www.nctm.org/uploadedFiles/Standards_and_Positions/Focus_in_High_School_Mathematics/FHSM_TeacherGuide.pdf (Accessed: 26 November 2018)

National Institute of Education Singapore (2018) *Justification in Mathematics.* Available at: https://www.nie.edu.sg/project/oer-01-16-cbl (Accessed: 26 November 2018)

Newman University (2017) *Code Of Practice For Research.* Available at: https://www.newman.ac.uk/wp-content/uploads/sites/10/2018/02/Code-of-Practice-for-Research.pdf (Accessed: 16 April 2019)

NFER (2016) *Twenty years of TIMSS in England.* Available at: https://www.nfer.ac.uk/publications/99958/99958.pdf (Accessed: 16 November 2018)

Ng, P. (2017) *Learning from Singapore: The Power of Paradoxes.* Oxon: Routledge

Nick Gibb MP (2014) *New Curriculum will make education system 'envy of the world'.* Available at: https://www.gov.uk/government/news/new-curriculum-will-make-education-system-envy-of-the-world (Accessed: 7 April 2019)

Nowell, L.S., Norris, J.M., White, D.E and Moules, N.J. (2017) 'Thematic Analysis: Striving to Meet the Trustworthiness Criteria', *International Journal of Qualitative Methods* [online only], DOI: https://doi.org/10.1177/1609406917733847.

O'hara, M., Carter, C., Dewis, P., Kay,J. and Wainwright, J. (2011) *Successful Dissertations: The Complete Guide For Education, Childhood and Early Childhood Studies students.* London: Continuum International Publishing Group.

O'Leary, K., Fitzpatrick, C.L. and Hallett, D. (2017) 'Math Anxiety Is Related to Some, but Not All, Experiences with Math', *frontiers in psychology* [online only], DOI: 10.3389/fpsyg.2017.02067

Ochs, K. (2006) 'Cross-National Policy Borrowing and Educational Innovaion: Improving Achievement in the London Borough of Barking and Dagenham', *Oxford Review of Education,* 32 (5), pp.599-618

OECD (2010) *Singapore: Rapid Improvement Followed by Strong Performance.* Available at: https://www.oecd.org/countries/singapore/46581101.pdf (Accessed: 1 April 2019)

OECD (2015) *Improving Schools in Sweden: An OECD Perspective.* Available at: http://www.oecd.org/education/school/Improving-Schools-in-Sweden.pdf (Accessed: 8 April 2019)

Pearson (2017) *Improving outcomes for primary pupils through maths mastery.* Available at: https://www.pearson.com/uk/educators/primary-educators/primary-news-and-policy/primary-blog/2017/02/improving-outcomes-for-primary-pupils-through-maths-mastery.html (Accessed: 7 April 2019)

Phillips, D. and Ochs, K. (2003) 'Processes of Policy Borrowing in Education: Some Explanatory and Analytical Devices', *Comparative Education,* 39 (4), pp. 451-461.

Precey, M. (2015) 'Teacher stress levels in England 'soaring', data shows', *BBC News,* 17 March. Available at: https://www.bbc.co.uk/news/education-31921457 (Accessed: 10 April 2019).

Priestley, M., Biesta, G. and Robinson, S. (2013) 'Teachers as Agents of Change: Teacher Agency and Emerging Models of Curriculum', in Priestly, M. and Biesta, G. (eds.) *Reinventing the Curriculum: New Trends in Curriculum Policy and Practice.* London: Bloomsbury Academic.

Pring, R. (2001) *Philosophy of Educational Research* London: Continuum

Rapp, S. (2010) 'Headteacher as a Pedagogical Leader: a Comparative Study of Headteachers in Sweden and England', *British Journal of Educational Studies,* 58 (3), pp.331-349

Roberts, J. (2018) 'Exclusive: England 'wrong to copy Shanghai maths', *TES News,* 20 July. Available at: https://www.tes.com/news/exclusive-england-wrong-copy-shanghai-maths (Accessed: 8 April 2019)

Royal Statistical Society (1995) *TACKLING THE MATHEMATICS PROBLEM.* Available at: http://mei.org.uk/files/pdf/Tackling_the_Mathematics_Problem.pdf (Accessed: 16 November 2018)

Ruddock, G. and Sainsbury, M. (2008) *Comparison of the Core Primary Curriculum in England to those of Other High Performing Countries.* Available at: https://www.nfer.ac.uk/publications/BPC01/BPC01.pdf (Accessed: 1 April 2019)

SAGE Secondary data analysis book

Schmidt, W., Houang, R. and Cogan, L. (2002) *A Coherent Curriculum: The Case of Mathematics.* Available at: https://www.math.mun.ca/~hsgaskill/refs/curriculum.pdf (Accessed: 16 November 2018)

Seaberg, R. (2015) 'Mathematics Lessons from Finland and Sweden', *MATHEMATICS TEACHER,* 108 (8), pp. 593-598

Sharma, Y. (2015) 'Western Schools envious of East Asian scores on global exam may change teaching methods', *South China Morning Post,* 13 April. Available at: https://www.scmp.com/lifestyle/family-education/article/1763278/western-schools-envious-east-asian-scores-global-exam-may (Accessed: 2 December 2018)

Smith, B. (2018) 'Generalizability in qualitative research: misunderstandings, opportunities and recommendations for the sport and exercise sciences', *Qualitative Research in Sport, Exercise and Health,* 10 (1), pp.137-149.

Smithers, A. (2004) *England's Education: what can be learned by comparing countries?* Available at: https://www.suttontrust.com/wp-content/uploads/2004/05/pisa_publication1-1.pdf (Accessed: 7 May 2019)

Tan, J. and Yates, S. (2010) 'Academic expectations as sources of stress in Asian students', *Social Psychology of Education,* 14 (3), pp.389-407.

Tan, P. (2010) 'Towards a Culturally Sensitive and Deeper Understanding of "Rote Learning" and Memorisation of Adult Learners', *Journal of Studies in International Education* [online only], DOI: https://doi.org/10.1177/1028315309357940.

Thyer, B. (ed.) (2010) *The Handbook of Social Work Research Methods.* London: SAGE Publications Ltd.

Thyer, B. (ed.) (2010) *The Handbook of Social Work Research Methods.* 2nd edn. London: SAGE Publications Ltd.

Timms, D. (2005) 'Guardian judged to be most trustworthy newspaper', *The Guardian,* 20 January. Available at: https://www.theguardian.com/media/2005/jan/20/theguardian.pressandpublishing (Accessed: 16 April 2019)

Turner, E. (2016) 'Top Maths teachers call for more funding for Singapore 'mastery' method', *The Telegraph,* 13 December. Available at:

https://www.telegraph.co.uk/education/2016/12/13/top-maths-teachers-call-funding-singapore-mastery-method/ (Accessed: 27 December 2018)

UCL News (2018) *England behind other countries in maths performance of disadvantaged pupils.* Available at: https://www.ucl.ac.uk/news/2018/apr/england-behind-other-countries-maths-performance-disadvantaged-pupils (Accessed: 6 May 2019)

Upagade, V. and Shende, A. (2008) *Research Methodology.* New Delhi: S.Chand & Company PVT. LTD.

Vartanian, T.P. (2011) *Secondary Data Analysis.* New York: Oxford University Press.

Wang, A.H., Coleman, A.B., Coley, R.J. and Phelps, R.P. (2003) *Preparing Teachers around the World. Policy Information Report.* Available at: https://files.eric.ed.gov/fulltext/ED479903.pdf (Accessed: 25 November 2018)

Webb, J.R. (ed.) (2002) *Understanding and Designing Market Research.* 2nd edn. Cornwall: Thomson Learning.

Wilkinson, R. and Pickett, K. (2010) *The Spirit Level: Why Greater Equality makes Stronger Societies.* New York: Bloomsbury Press.

Williams, P. (2008) *Independent Review of Mathematics Teaching in Early Years Settings and Primary Schools.* Available at: http://dera.ioe.ac.uk/8365/7/Williams%20Mathematics_Redacted.pdf (Accessed: 14 November 2018)

Wong, L.P. (2008) 'Data Analysis in Qualitative Research: A Brief Guide to Using Nvivo', *Malaysian Family Physician,* 3 (1), pp. 14-20

Wood, J. (2018) *Children in Singapore will no longer be ranked by exam results. Here's why.* Available at: https://www.weforum.org/agenda/2018/10/singapore-has-abolished-school-exam-rankings-here-s-why/ (Accessed: 8 May 2019)

Woodfield, K. (ed.) (2018) *The Ethics of Online Research.* Bingley: Emerald Publishing Ltd.

Zickermann, P. (2014) *Co-Branding: Fit Factors Between Partner Brands.* Hamburg: Anchor Academic Publishing.

Appendix 1:

The tables below show the TIMSS positioning of Singapore, Sweden and England in Grade 4 maths in 1995, 2003, 2007, 2011 and 2015. The United States has also been used as a comparator in the results section due to TIMSS being of American origin with its main aim being to compare America's progress in maths to other countries worldwide.

Table A (1995):

Fourth Grade* Country	Average Achievement	Third Grade* Country	Average Achievement
Singapore	625	**Korea**	561
Korea	611	**Singapore**	552
Japan	597	**Japan**	538
Hong Kong	587	**Hong Kong**	524
Netherlands	577	**Czech Republic**	497
Czech Republic	567	*Netherlands*	493
Austria	559	*Slovenia*	488
Slovenia	552	*Austria*	487
Ireland	550	*Australia*	483
Hungary	548	**United States**	480
Australia	546	*Hungary*	476
United States	545	**Ireland**	476
Canada	532	**Canada**	469
Israel	531	*Latvia (LSS)*	463
Latvia (LSS)	525	*Scotland*	458
Scotland	520	**England**	456
England	513	*Thailand*	444
Cyprus	502	**New Zealand**	440
Norway	502	**Cyprus**	430
New Zealand	499	**Greece**	428
Greece	492	**Portugal**	425
Thailand	490	**Norway**	421
Portugal	475	**Iceland**	410
Iceland	474	**Iran, Islamic Republic**	378
Iran, Islamic Republic	429		
Kuwait	400		
International Average	529	International Average	470

Achievement in Mathematics

Table B (2003):

Country	Average Score
International Average	495
Singapore	594
Hong Kong SAR[1,2]	575
Japan	565
Chinese Taipei	564
Belgium-Flemish	551
Netherlands[2]	540
Latvia	536
Lithuania[3]	534
Russian Federation	532
England[2]	531
Hungary	529
United States[2]	**518**
Cyprus	510
Moldova, Republic of	504
Italy	503
Australia[2]	499
New Zealand	493
Scotland[2]	490
Slovenia	479
Armenia	456
Norway	451
Iran, Islamic Republic of	389
Philippines	358
Morocco	347
Tunisia	339

■ Average is higher than the U.S. average.
□ Average is not measurably different from the.
□ Average is lower than the U.S. average

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2003.

Table C (2007):

Table D (2011):

Grade four	
Country	**Average score**
TIMSS scale average	500
Hong Kong SAR[1]	607
Singapore	599
Chinese Taipei	576
Japan	568
Kazakhstan[2]	549
Russian Federation	544
England	541
Latvia[2]	537
Netherlands[3]	535
Lithuania[2]	530
United States[4, 5]	**529**
Germany	525
Denmark[4]	523
Australia	516
Hungary	510
Italy	507
Austria	505
Sweden	503
Slovenia	502
Armenia	500
Slovak Republic	496
Scotland[4]	494
New Zealand	492
Czech Republic	486
Norway	473
Ukraine	469
Georgia[2]	438
Iran, Islamic Rep. of	402
Algeria	378
Colombia	355
Morocco	341
El Salvador	330
Tunisia	327
Kuwait[6]	316
Qatar	296
Yemen	224

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2007.

Grade 4	
Education system	Average score
TIMSS scale average	500
Singapore[1]	606 △
Korea, Rep. of	605 △
Hong Kong-CHN[1]	602 △
Chinese Taipei-CHN	591 △
Japan	585 △
Northern Ireland-GBR[2]	562 △
Belgium (Flemish)-BEL	549 △
Finland	545
England-GBR	542
Russian Federation	542
United States[1]	**541**
Netherlands[2]	540
Denmark[1]	537
Lithuania[1,3]	534 ▽
Portugal	532 ▽
Germany	528 ▽
Ireland	527 ▽
Serbia[1]	516 ▽
Australia	516 ▽
Hungary	515 ▽
Slovenia	513 ▽
Czech Republic	511 ▽
Austria	508 ▽
Italy	508 ▽
Slovak Republic	507 ▽
Sweden	504 ▽
Kazakhstan[1]	501 ▽
Malta	496 ▽
Norway[4]	495 ▽
Croatia[1]	490 ▽
New Zealand	486 ▽
Spain	482 ▽
Romania	482 ▽
Poland	481 ▽
Turkey	469 ▽
Azerbaijan[1,5]	463 ▽
Chile	462 ▽
Thailand	458 ▽
Armenia	452 ▽
Georgia[3,5]	450 ▽
Bahrain	436 ▽
United Arab Emirates	434 ▽
Iran, Islamic Rep. of	431 ▽
Qatar[1]	413 ▽
Saudi Arabia	410 ▽
Oman[6]	385 ▽
Tunisia[6]	359 ▽
Kuwait[3,7]	342 ▽
Morocco[7]	335 ▽
Yemen[7]	248 ▽

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2011.

Table E (2015):

Education system	Average score	s.e.
TIMSS scale centerpoint	500 ▼	0.0
Singapore[1]	618 ▲	3.8
Hong Kong-CHN[2]	615 ▲	2.9
Korea, Rep. of	608 ▲	2.2
Chinese Taipei-CHN	597 ▲	1.9
Japan	593 ▲	2.0
Northern Ireland-GBR[3]	570 ▲	2.9
Russian Federation	564 ▲	3.4
Norway (5)[4]	549 ▲	2.5
Ireland	547 ▲	2.1
England-GBR	546	2.8
Belgium (Flemish)-BEL[2]	546 ▲	2.1
Kazakhstan	544	4.5
Portugal[1]	541	2.2
United States[1, 2]	**539**	**2.3**
Denmark[1, 2]	539	2.7
Lithuania[1]	535	2.5
Finland	535	2.0
Poland	535	2.1
Netherlands[2]	530 ▼	1.7
Hungary	529 ▼	3.2
Czech Republic	528 ▼	2.2
Bulgaria	524 ▼	5.3
Cyprus	523 ▼	2.7
Germany	522 ▼	2.0
Slovenia	520 ▼	1.9
Sweden[1]	519 ▼	2.8
Serbia[5]	518 ▼	3.5
Australia	517 ▼	3.1
Canada[1, 2, 6]	511 ▼	2.3
Italy[1]	507 ▼	2.6
Spain[1]	505 ▼	2.5
Croatia	502 ▼	1.8
Slovak Republic	498 ▼	2.5
New Zealand	491 ▼	2.3
France	488 ▼	2.9
Turkey	483 ▼	3.1
Georgia[6]	463 ▼	3.6
Chile	459 ▼	2.4
United Arab Emirates	452 ▼	2.4
Bahrain[1]	451 ▼	1.6
Qatar	439 ▼	3.4
Iran, Islamic Rep. of	431 ▼	3.2
Oman	425 ▼	2.5
Indonesia	397 ▼	3.7
Jordan	388 ▼	3.1
Saudi Arabia[7]	383 ▼	4.1
Morocco	377 ▼	3.4
Kuwait[7]	353 ▼	4.6

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2015.

Appendix 2:

The tables below provide a description of what each of the international benchmarks entail. It provides the reader with an idea of what pupils in each of the countries had achieved during the TIMSS tests administered to Grade 4.

Table 1 (Low international Benchmark):

TIMSS 2015 Mathematics 4th Grade

Exhibit 2.4: Description of the TIMSS 2015 Low International Benchmark (400) of Mathematics Achievement

400 Low International Benchmark

Summary

Students have some basic mathematical knowledge. They can add and subtract whole numbers, have some understanding of multiplication by one-digit numbers, and can solve simple word problems. They have some knowledge of simple fractions, geometric shapes, and measurement. Students can read and complete simple bar graphs and tables.

Students at this level are familiar with numbers into the thousands. They can add and subtract whole numbers, have some understanding of multiplication by one-digit numbers, and can solve simple word problems. They can recognize pictorial representations of simple fractions.

Students have some recognition of simple two- and three-dimensional shapes and basic measurement ideas.

Students can read and complete simple bar graphs and tables.

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2015

IEA TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College

Table 2 (Intermediate International Benchmark):

TIMSS 2015 Mathematics 4th Grade

Exhibit 2.5: Description of the TIMSS 2015 Intermediate International Benchmark (475) of Mathematics Achievement

475 Intermediate International Benchmark

Summary

Students can apply basic mathematical knowledge in simple situations. They demonstrate an understanding of whole numbers and some understanding of fractions and decimals. Students can relate two- and three-dimensional shapes and identify and draw shapes with simple properties. They can read and interpret bar graphs and tables.

Students at this level demonstrate an understanding of whole numbers. They can add and subtract as well as multiply and divide by one-digit numbers in a variety of situations, including problems involving two steps. Students have some basic understanding of fractions and decimals. They can identify expressions representing simple situations.

Students can relate two- and three-dimensional shapes and compare volumes made with cubes. They can identify and draw shapes with simple properties, including right angles.

Students can read and interpret information in bar graphs and tables.

IEA TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College

Table 3 (High International Benchmark):

TIMSS 2015 Mathematics 4th Grade

Exhibit 2.6: Description of the TIMSS 2015 High International Benchmark (550) of Mathematics Achievement

550 High International Benchmark

Summary

Students can apply their knowledge and understanding to solve problems. They can solve word problems involving operations with whole numbers, simple fractions, and two-place decimals. Students demonstrate understanding of geometric properties of shapes and of angles that are less than or greater than a right angle. Students can interpret and use data in tables and a variety of graphs to solve problems.

Students at this level have a conceptual understanding of whole numbers which they can apply to solve word problems. They can multiply two-digit numbers and perform division with a remainder. They show some understanding of multiples and factors and can round numbers. Students can add and subtract two-place decimals. They can relate different representations of fractions in problem situations. Students can identify an expression that represents a situation and solve simple number sentences.

Students can classify and compare a variety of shapes based on properties. They can compare and draw angles that are less than or greater than a right angle. Students can locate positions and carry out movements on lines and grids. They demonstrate understanding of line symmetry.

Students can solve problems by interpreting data presented in tables, pie charts, pictographs, and bar graphs labeled with intervals greater than one. They can compare data from two representations to draw conclusions.

Table 4 (Advanced International Benchmark)

TIMSS 2015 Mathematics 4th Grade

Exhibit 2.7: Description of the TIMSS 2015 Advanced International Benchmark (625) of Mathematics Achievement

625 Advanced International Benchmark

Summary

Students can apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning. They can solve a variety of multi-step word problems involving whole numbers. Students at this level show an increasing understanding of fractions and decimals. They can apply knowledge of a range of two- and three-dimensional shapes in a variety of situations. They can interpret and represent data to solve multi-step problems.

Students can solve a variety of multi-step word problems involving whole numbers. They can find more than one solution to a problem and solve number sentences with operations on both sides. Students can solve problems that show an increased understanding of fractions, including explanation of pictorial representations of fractions. They can solve problems involving both one- and two-place decimals.

Students can apply knowledge of a range of two- and three-dimensional shapes in a variety of situations. They can draw parallel and perpendicular lines to satisfy given conditions. Students can solve problems involving area and perimeter of simple shapes. They can read a ruler to find the length of an object beginning or ending at a half-unit.

Students can interpret and represent data to solve multi-step problems.

Appendix 3:

Table 1:

Table 1.2:

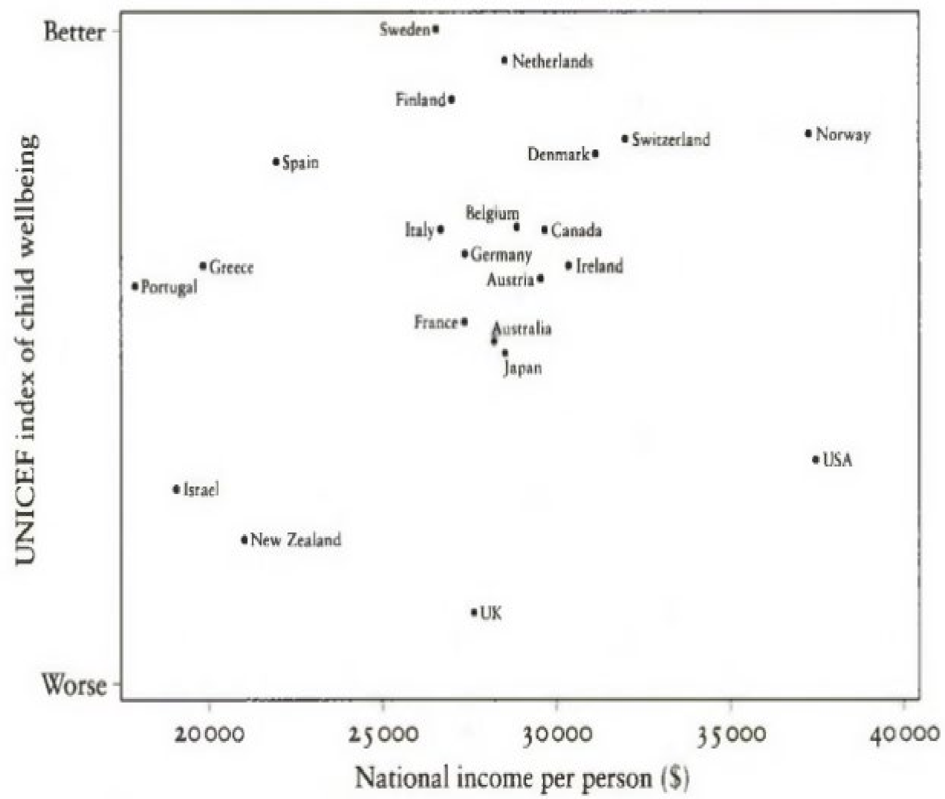


Table 2:

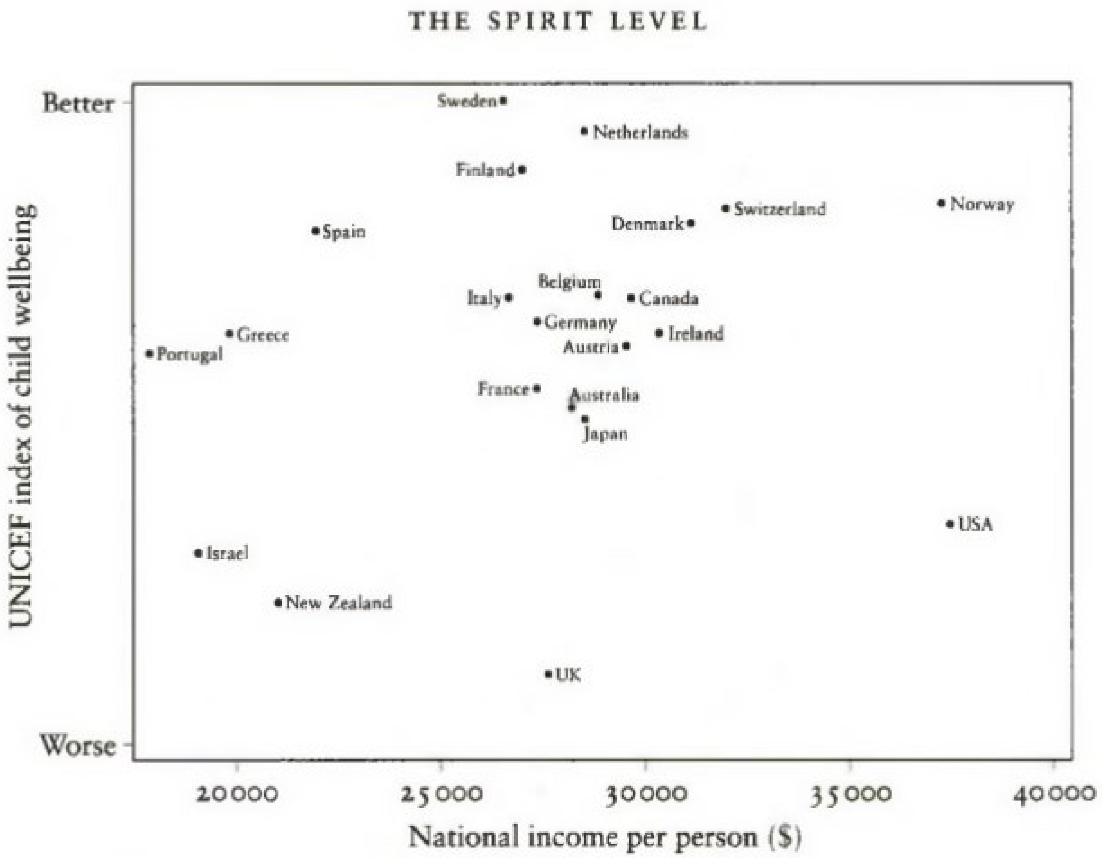
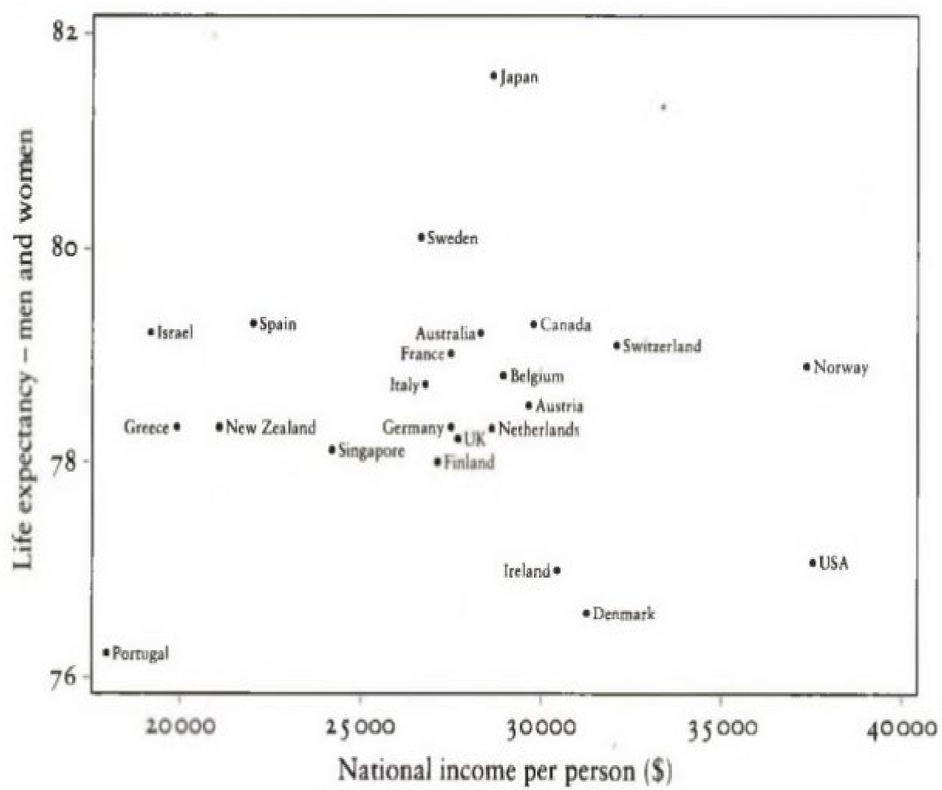


Table 3:



(Wilkinson and Pickett, 2010)

Table 4:

CHILD WELL-BEING IN RICH COUNTRIES: A SUMMARY TABLE

The chart below presents the findings of this *Report Card* in summary form. Countries are listed in order of their average rank for the six dimensions of child well-being that have been assessed.[1] A light blue background indicates a place in the top third of the table; mid-blue denotes the middle third and dark blue the bottom third.

		Dimension 1	Dimension 2	Dimension 3	Dimension 4	Dimension 5	Dimension 6
Dimensions of child well-being	Average ranking position (for all 6 dimensions)	Material well-being	Health and safety	Educational well-being	Family and peer relationships	Behaviours and risks	Subjective well-being
Netherlands	4.2	10	2	6	3	3	1
Sweden	5.0	1	1	5	15	1	7
Denmark	7.2	4	4	8	9	6	12
Finland	7.5	3	3	4	17	7	11
Spain	8.0	12	6	15	8	5	2
Switzerland	8.3	5	9	14	4	12	6
Norway	8.7	2	8	11	10	13	8
Italy	10.0	14	5	20	1	10	10
Ireland	10.2	19	19	7	7	4	5
Belgium	10.7	7	16	1	5	19	16
Germany	11.2	13	11	10	13	11	9
Canada	11.8	6	13	2	18	17	15
Greece	11.8	15	18	16	11	8	3
Poland	12.3	21	15	3	14	2	19
Czech Republic	12.5	11	10	9	19	9	17
France	13.0	9	7	18	12	14	18
Portugal	13.7	16	14	21	2	15	14
Austria	13.8	8	20	19	16	16	4
Hungary	14.5	20	17	13	6	18	13
United States	18.0	17	21	12	20	20	–
United Kingdom	18.2	18	12	17	21	21	20

OECD countries with insufficient data to be included in the overview: Australia, Iceland, Japan, Luxembourg, Mexico, New Zealand, the Slovak Republic, South Korea, Turkey.