Teaching and learning mathematics in Karachi's low-cost private schools

Asyia Kazmi

Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Education

University College London

Institute of Education

Curriculum, Pedagogy and Assessment

July 2019

Declaration

I, Asyia Kazmi confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Word count (exclusive of appendices, the list of references and bibliographies but including footnotes, endnotes, glossary, maps, diagrams and tables): 45,096 words.

Asyia Kazmi

July 2019

Abstract

To improve learning-outcomes teaching quality matters. However, research into teaching in low- and middle-income countries (L&MIC) is limited, particularly in mathematics and the rapidly rising low-cost private sector (LCPS).

The purpose of this research is to study mathematics teaching and learning in Karachi's LCPS by exploring four related aspects: who attends Karachi's LCPS-school; the values that underpin LCPS teachers' instructional and professional practices; the instructional practices teachers use to teach mathematics; and the institutional environment that supports or hinders the development of mathematics teaching practice.

Five key components of effective teaching underpinned by communicative pedagogies are explored in this study in relation to LCPS teachers' practice: planning and preparation; a conducive classroom environment; effective instructional practices; independent practice and summative assessment; and teachers' role as professionals. Employing a mixed-method case-study approach, this study uses primary data gathered through lesson observations and interviews conducted in five pilot and two in-depth case-study LCPS-schools, and secondary quantitative data. This thesis employs a pragmatic perspective on the school effectiveness and improvement research framework and argues for its greater use in identifying good practice in L&MIC.

LCPS teachers are unqualified, untrained and poorly paid but driven by a strong sense of moral purpose underpinned by a transformational view of education. They exhibit a continuum of practice from novice to expert with the latter reflecting the same components of effective practices found in HIC literature.

My findings show LCPS teachers can be supported to become expert through a systematic programme of professional development and a supportive accountability framework. Therefore, this study argues for support to be provided to LCPS teachers on developing students' conceptual understanding, embedding formative assessment and promoting mathematical communication. It concludes with recommendations for policymakers to engage with the LCPS at a systemic level to promote equity and improve learning.

Dedicated to my father

Syed Abdul Hakeem Kazmi

1936 - 2013

Knowledge exists potentially in the human soul like the seed in the soil; by learning, the potential becomes actual.

The teacher must adapt their teaching to the pupils' capacity and ability.

Al-Ghazali (circa 1010)

Acknowledgements

My heartfelt thanks to my supervisors Dr Clare Bentall and Professor Candia Morgan for their patience and perseverance. I truly appreciated their detailed and challenging supervision of my thesis.

Thank you to all my teachers and a sincere thank you to the teachers of my pilot and case-study schools. I valued the time they gave to me and their engagement with my work. Their commitment and enthusiasm continues to inspire me.

Undertaking a professional doctorate, it would be remiss of me to not acknowledge the support provided by my colleagues in the DfE, DFID, Ofsted and PwC as well as the amazing tutors and students on the EdD programme.

Throughout my doctorate journey I have been blessed with amazing family and friends who encouraged, supported and cajoled:

- I would not be where I am today without Teresa Smart, my friend and my mentor
- My brothers and sisters, especially Sadyia, thank you
- My sons, you can stop lecturing me to finish now
- My husband, thank you for your unwavering support.

Finally, thank you to my father, who sacrificed so much. He taught us that seeking knowledge is an obligation and he taught us to value knowledge and learning above possessions. May we all continue this legacy.

Contents

Table of Figures

List of Acronyms

Acronym	
AfL	Assessment for Learning
ASER	Annual Status of Education Report
DFID	Department for International Development, United Kingdom
EdD	Doctorate in Education
EFS	Education Fund for Sindh, a not-for-profit company set up and funded by DFID
FoP	Foundations of Professionalism
FGD	Focus group discussion
HIC	High-income countries
HMI	Her Majesty's Inspector
L&MIC	Low- and middle-income countries
LCPS	Low cost private sector
LCPS-schools	Low cost private sector schools
MoE	Methods of Enquiry
NGO	Non-Government Organisations
OFSTED	Office for Standards in Education, England
OPM	Oxford Policy Management
PS	Pilot-school
PwC	PriceWaterhouseCoopers
RQ	Research question
Rs	Pakistani Rupees
SER	School effectiveness research
SEIR	School effectiveness and improvement research
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States of America
USAID	United States Agency for International Development

Personal Statement

It has taken a long time to complete my doctorate because of five significant and demanding changes in my professional role while undertaking the EdD. Serendipitously, these roles have all benefited from my studies and vice versa. In this section I reflect on my personal, professional and educational journey in relation to these roles in high-income countries (HIC) and in low- and middle-income countries (L&MIC).

Role 1: My EdD began when I was a Project Director at the UK's Department for Education (DfE) leading a national project on minority ethnic achievement in England. In order to be informed I engaged intensively with research and decided to formalise this by pursuing a doctorate. I loved the taught courses and thrived on the plethora of incredibly well-informed, passionate academics lecturing on a wide range of topics. The content was inspiring and energising, speaking to my idealised notions of education based on equity and social justice.

Inexperienced at working on policy at a national level, the EdD helped to bring an evidence-based academic rigour to the design of the programme I was leading. The concept of the relationship between society and professions studied in Foundations of Professionalism (FoP) struck a chord which has remained with me. It made me reflect on my role as a policymaker and challenged me to consider how I contribute to teachers' and educators' professionalism. This has resonated throughout my professional roles, particularly as these became increasingly senior, extending in reach and potential impact. For example, as a HMI I delivered training which sought to develop collegiality and school-to-school learning. I continue to seek opportunities for self- and collective learning.

FoP developed in me the skills to be critical and to look at myself and my role from an outsiders' perspective. Being a naturally optimistic person eager to test out new ideas, FoP taught me to slow down and examine who policy directives come from and why. It formalised in me the ability to question whether prescription is informed or uninformed and whether it creates informed or

uninformed professionals. I use this and continuously engage with research to guard against possible negative impact that my work could have. For example, when considering the role of the private sector I reflected on who benefits, who is excluded or exploited, and how policy can encourage equity.

Professionally the EdD improved my practice. It made me engage with critics and take diverse views on board, be willing to adapt ideas and be less prescriptive. When I was enthusiastically working on national programmes, the EdD taught me to be more objective and to consider longer term implications of short-term programmes. For example, when encouraging schools to work with parents, I explored whether successful practice could be sustainable when funding stopped and if so how. The EdD also crystallised the power of critique and criticism for me. Seeking and embracing critique of my practice not only enabled better policymaking but also enabled me to implement it more effectively. Often teachers would report that time limitations prevented them from taking on the recommended activities but FoP encouraged systems thinking. Therefore, I engaged with headteachers and local authority officials to explore opportunities for a more constructive and supportive environment for teachers. We designed opportunities which recognised and respected teachers' professionalism, making time to share practice so teachers learnt with and from each other.

The academic discourse in FoP focused on equity resonated strongly with me, professionally and personally. However, after this focus on equity and inclusion, the language of Methods of Enquiry 1 seemed exclusive. I not only struggled with the content and vocabulary but also how it was communicated. Initially I considered questions such as 'How do you know you know?' self-indulgent. Although, at the time, it was challenging to grasp concepts such as validity and reliability I appreciate the importance of this discipline, which has increased in relevance in successive professional roles. My work on programmes which have had a global audience requires regular use and generation of evidence. Therefore, taking a critical stance on the quality of, and the methodology for, producing it has been a crucial skill I acquired through my studies.

Role 2: I then moved to Ofsted as one of Her Majesty's Inspectors (HMI). The data analysis expertise I developed in Methods of Enquiry 2, resulted in my being made responsible for both the quantitative and qualitative analysis of Ofsted's high-profile annual report. I advised colleagues on their methodology for data collection and the caveats they had to put in place when making assertions based on their analysis.

In the Contemporary Education Policy course I explored the genesis of inspection and its evolution to the current inspection framework, further developing my critical analysis skills. The study of policy history was incredibly useful as I trained other government officials on how inspection operated in the English context. Reflecting on why and how inspection evolved made these sessions more credible and relevant.

My Institute Focused Study resulted in the first break in my EdD as approval to research the impact of inspection on schools that went from failing to good took substantial time. I conducted a mixed-methods case-study using interviews, document and data analysis to explore the impact of HMI visits to schools that were in special measures. I returned to this methodological approach for my final thesis. In this junction of professional role and studies I learnt how to separate my personal and professional self and critically examine organisation, systems and structures. This reflection on my own organisation was insightful, particularly exploring the structures that enable and debilitate individuals. It made me a better, more reflective professional, taking account of the personal in my professional endeavours for school improvement.

Role 3: From Ofsted I moved to the UK's Department for International Development (DFID) in 2011 as a Senior Education Adviser, stationed in Pakistan, leading a large education portfolio with a new team implementing new programmes. As a result of a high workload my EdD was paused. Nevertheless, nearly every aspect of my studies informed my work. I was responsible for commissioning research, including impact evaluations, and both MoE 1 and 2 ensured that I was able to engage with experts in an informed and critical way. FoP was even more relevant in the international development context, particularly reflecting on who the subject of the profession was and how to

ensure they have a voice. I was conscious of designing our programmes in consultation with stakeholders, using evidence and putting in safeguards to promote equity. For example, I instigated a pilot before rolling out a large programme, incorporating a gender equity analysis, which helped to get over 100,000 children into school.

I was responsible for implementing policies that had the potential to have substantial impact on Pakistan's education system. Key skills developed through the EdD became acutely relevant, including the ability to critically engage with and use research, and consider carefully, often polarised, sides of argument. The role exposed me to the economics of education. It was jarring, in the face of my beliefs in education as a right and a good for its own sake, to consider the rates of return, the opportunity costs and benefits of education. However, faced with a limited resource envelope and millions of out-of-school children I became more sympathetic to the harsh realities facing policymakers and studied this topic more academically. Arguments were most polarised around the role of the private sector in education and most relevant in the context of parental choice and resource-constrained countries. My reflection was that the existing research on this topic was focused on structures, private versus public, rather than what helps children learn and thrive, which led to my thesis proposal and underlined the importance of research that is detailed and nuanced at the classroom level, a missing perspective in L&MIC.

Role 4: I returned to Ofsted as a Senior HMI in 2014 and began the thesis stage. Based on my professional experience, my instinct is to focus on teaching, learning and assessment to improve education. This, therefore, became the pedagogical focus of my thesis and gave my subsequent professional roles an academic underpinning. Engagement with MoE and my professional background meant I gravitated towards school effectiveness and improvement research. This, combined with the lack of evidence on what works at the classroom level to improve learning-outcomes in L&MIC, informed my thesis design.

Role 5: In 2016 I joined PriceWaterhouseCoopers (PwC) as a Team Leader of DFID's largest policy programme, the Girls' Education Challenge, funding 38

projects in 17 countries. Every aspect of my EdD studies was utilised in this role: from engaging in an authoritative way on qualitative and quantitative evaluations; reflecting on how to accelerate learning-outcomes; considering how we encourage lesson-learning within the team and across the projects; and working with, not on, the communities where our projects operate. The programme focuses on measuring literacy and numeracy as high-level outcomes. Therefore, ideas regarding professional values, such as defining what knowledge has the most worth and what is transformative, took on increased poignancy.

The EdD's unit on theorising policy and policymaking was an important foundation for my work in Ofsted and DFID. These roles intended to bring about changes in practices and structures, and promote social justice. However, Lall's (2006) views on new public management, encouraging continual instability, uncertainty and fabrication, are particularly pertinent when leading programmes focused on performativity. Balancing compliance costs of adhering to requirements while building collegial professionalism and providing value for money for taxpayers are challenges continually facing the programme.

Summary

Prior to undertaking the EdD, I was an uninformed professional, blasé about intellectual rigour, who did not recognise the discipline that goes into academic research. This was addressed through the academic writing process which I found incredibly challenging: from defining commonly accepted terms to developing theoretical frameworks to maintaining focus. I have learnt the discipline of what can be asserted based on the methodology employed and provide the evidence for it. I have understood the difference between using my professional experience to do the right thing and having the research skills to provide evidence that it is indeed the right thing to do.

In my EdD field visits I was humbled by the aspirational and transformational view of teaching held by teachers. In the day to day business of our roles we are at risk of forgetting the power of teachers and of this wonderful, honourable vocation. My studies and my professional roles have reaffirmed the impact of

teachers even more and increased my passion to contribute to this profession and its professionals. I have already shared the thesis with DFID Pakistan and regularly use it to inform my current work.

It is an obligation on every Muslim to seek knowledge and, although very challenging, it has been an immense privilege to get to this point, combining my professional, religious and personal aspirations.

On a personal level, my father who fulfilled the role of both parents for much of my life passed away in March 2013. Though not highly qualified himself, my father valued education as a societal and religious duty and dreamed of me attaining a doctorate. My father is with us no more and the thesis is complete.

Abu it's now done. I hope you are up there smiling gently in recognition and in answer to your ubiquitous question 'what next?' I think a short, practical course, perhaps dress-making or flower arranging.

Chapter 1 Introduction

This is a study of teaching and learning mathematics in Karachi's low-cost private sector (LCPS) primary schools. It focuses on how teachers teach mathematics to poor children funded by the UK's Department for International Development (DFID) to attend LCPS-schools (DFID, 2013).

In this chapter I explain the academic and personal rationale for this focus, the context of this research and the structure of this thesis.

1.1 The rationale for this research

The benefits to the economy, health and good citizenship are cited as direct results of education (GMR Policy Paper 4, 2012). However, not only are 263 million children out-of-school, an estimated 250 million children do not acquire basic literacy and numeracy skills despite being in school (DFID, 2013; World Bank, 2017). Furthermore, it is learning-outcomes that are more strongly associated with increases in earnings and development outcomes for individuals than schooling (Hanushek & Woessmann, 2007). Against this backdrop, the context for this research is threefold:

1. My professional experience in England as a mathematics teacher, adviser and Her Majesty's Inspector (HMI) has consistently highlighted the importance of effective teaching and learning in the classroom. However, limited evidence is available on instructional practices in L&MIC, hindering the ability to understand and improve teaching in these contexts (Westbrook, et al., 2013; Piper, et al., 2018).
2. My role as an adviser in DFID Pakistan led me to explore the role of the LCPS in improving access to education for Pakistan's out-of-school population. This sector is rapidly increasing in L&MIC in general and in Pakistan in particular, resulting in a need for research to understand who accesses and benefits from it and how (Day, et al., 2014).
3. The significance of the school effectiveness and improvement research (SEIR) framework in my professional life which articulates the difference schools make to learning and how. This lens is missing in L&MIC research

and, therefore, policy is informed by too little information about what works at the classroom level.

This context combined with a research gap in each aspect came together to provide my research focus. My proposition is that the fundamentals of good teaching and learning are universal. Therefore, I seek to test this in the LCPS which is a sector of growing interest for donors due to its relatively higher learning-outcomes at lower cost in Pakistan.

My professional background has involved evaluating teachers' practice, inspecting schools and educational institutions, and advising and training teachers and education professionals. This has given me wide-ranging knowledge and perspectives on effective teacher pedagogy. My responsibilities as HMI have meant I was trained to judge, but not study, teaching and learning. However, my professional experience, I believe, will complement the academic lens and help me to gain a deeper understanding of what I am studying.

Next, I set out why I focus on mathematics teaching and LCPS-schools in Pakistan. I then outline my methodology which is informed by the SEIR framework.

1.2 A focus on mathematics teaching

Evidence from L&MIC shows that improving teaching, focusing on what a teacher does and what the teacher believes, is the most effective way of improving students' learning-outcomes (Aslam & Kingdon, 2011; Singh & Sarkar, 2012). While it is accepted that teacher quality matters, the literature indicates less is known about the impact of this in L&MIC with little subject specific commentary (Bold, et al., 2018; Glewwe & Muralidharan, 2016; Westbrook, et al., 2013). More than literacy, early mathematics skills are strongly predictive of later school success (Tredoux & Dawes, 2018). However, substantial attainment gaps exists globally in mathematics learning-outcomes due to students' socioeconomic characteristics (Tayyaba, 2012; Bonner, 2014). Household wealth when a child is a year old has been linked to their mathematics achievement 10 years later (Cueto, et al., 2014; Cueto, et al., 2017).

It is recognised that to improve learning-outcomes teaching quality has to improve (Hanushek & Woessmann, 2007) and that communicative, dialogic pedagogy plays an important role in this (Westbrook, et al., 2013). However, while research highlights how summative information can be used, there is limited empirical evidence on the components of instructional practices that improve teaching in literacy and even less in mathematics (Piper, et al., 2016). My interest in teaching stems from my professional experience which has consistently highlighted the importance of effective instructional practices that incorporate teachers' scaffolding and modelling learning, guiding students' practice through formative assessment including questioning, and school-level assessment systems to improve and accelerate learning (Pritchett & Banerji, 2013; Black & Wiliam, 1998).

To know and understand teachers' instructional practices in mathematics I need to also understand the values that inform this, particularly in relation to underprivileged students. Therefore, my research aims to explore teaching in mathematics from a pedagogical perspective in order to broaden the research base in Pakistan. I turn next to the site of my research, the LCPS.

1.3 The rapid rise of low-cost private schooling in Pakistan

Many poor countries enrol a much larger share of primary aged students in private schools than richer countries providing a damning indictment of the perception of government schools in L&MIC countries (The Economist, 2015).

Pakistan is a middle-income country but scores low on the Human Capital Index; its adjusted learning years is only 4.8 out of the recommended 12 (World Bank, 2018a). Free and compulsory education is mandated in Pakistan's constitution for its 21 million primary aged children; of whom 5.6 million are out-of-school and combined with low government spending on education, universal primary education is not yet within reach (UNESCO, 2012; UNESCO, 2016). Despite the availability of free government schools, literacy levels remain poor, and substantial cost implications for educating children exists such as uniforms, books and transportation, particularly for the poorest (Alif Ailaan, 2015). Against this backdrop, a burgeoning private sector in Pakistan is helping to bridge the gap accounting for 30% of current school enrolment; in major urban areas such

as Karachi, this is as high as 50% (Pakistan Bureau of Statistics, 2012). Accurate data collection is an issue and there are many unregistered LCPS-schools making it likely this proportion is higher.

No set definition of a LCPS-school exists. The US government defines the cost of private school education as a percentage of the minimum wage (Heyneman, Stern, & Smith, 2012) whereas others use household income as the means of defining school fees (Barakat, et al., 2014). In Pakistan LCPS-schools typically charge fees of around 400Rs (£2.16) per month making them accessible to low-income but not the lowest-income families (Mcloughlin, 2013).

Governments and donors are responding to the demand for private education and providing financial support to parents often in the form of vouchers to cover school fees. A well-designed equity-focused scheme that enables publicly-funded privately-delivered education can benefit the poorest and has the potential to help education systems to improve (Patrinos, 2012; Watkins, 2012). However, its design must guard against middle-class capture, and aggressive and iniquitous selection processes which privilege those who already have voice and choice (Sandefur, 2012). Vouchers can improve competition, which in turn can improve quality. However, a counterargument is that private providers are unaccountable resulting in less public control and greater segregation (Patrinos, 2012). Support of the LCPS is seen as bypassing government, which not only absolves it of its duty and condones its failure but assumes the LCPS has the scale and reach that only government can provide (Watkins, 2012). In addition, parents' socio-economic characteristics can lead to segregation by income and academic achievement when implementing public private partnership (Patrinos, et al., 2009).

There is inconsistent evidence regarding girls' and boys' access to LCPS-schools, with the perception that societies that privilege boys will enrol them in private schools and keep girls in less effective schools or at home (Aslam, 2009; Aslam & Kingdon, 2011; Mcloughlin, 2013). However, research from Pakistan shows that government subsidies for private schools increased female access to education (Fennel, 2012) and in rural Pakistan the presence of private schools is strongly associated with female enrolment (Andrabi, et al.,

2013). Nevertheless, exclusion of the poorest is clearly a matter of concern (Watkins, 2012; Day, et al., 2014).

The LCPS is essentially demand led and reflective of the failure of government schools to deliver quality, as well as the failure of international institutions whose focus on access has been at the expense of quality (Watkins, 2012). After controlling for intake ability and social background, there is evidence that LCPS-schools have better teaching despite lower instructional time and deliver higher learning-outcomes with lower costs in Pakistan and India (Sandefur, 2012; Mcloughlin, 2013; Day, et al., 2014; Muralidharan & Sundararaman, 2015).

In Pakistan teaching in LCPS-schools provides a source of employment for young women who have completed secondary education and this supply in turn leads to growth of the LCPS (Barakat, et al., 2014). These young women have limited experience and qualifications but are able to deliver improved learning-outcomes (Bannerjee & Duflo, 2011). An explanation for better quality teaching in LCPS-schools is greater accountability of teachers; those who do not perform are dismissed (Day, et al., 2014). Another accountability factor identified is an emphasis on regular summative assessment, reflecting Wiliam's (2011) findings regarding improvement of weak education systems. The sector is also known for its more interactive teaching approaches (Aslam & Kingdon, 2011).

There is also an economic and market perspective of the LCPS. Although contentious, it is big business with the potential size of impact investment in education in L&MIC being placed at $5-10bn (JP Morgan Global Research, 2010). Providers of private education are motivated by profit but some researchers suggest a more benign philanthropic, social responsibility driver (Barakat, et al., 2014).

The research literature considers LCPS-schools as a homogenous group and does not expand on between-school differences within the sector, particularly in relation to teaching and learning, nor does it illuminate how it can improve. It is this aspect that my research focuses on, seeking to understand what teaching

and learning are like within Karachi's LCPS and by exploring instructional practices to consider the focus for improvement work.

I turn next to the research tradition in which my research sits.

1.4 The case for school effectiveness and improvement research lens

The LCPS is not the panacea to educational ills. Learning-outcomes comparing private schools with state schools indicate they are less bad rather than good: only 67% of class 5 students in Pakistani private schools can read a short story compared to 52% in government schools (ASER, 2016).

School effectiveness research (SER), which links learning-outcomes to components of pedagogy, identified that schools account for 10% of achievement when controlled for socio-economic factors in HIC and 28% in L&MIC, even more for underprivileged students (Stoll & Fink, 1996; Hanushek & Woessmann, 2007). However, an integration of school effectiveness and school improvement research disciplines was sought by researchers and practitioners to give the latter the rigour of measuring impact and the former an understanding of how to socialise and contextualise change from the bottom up (Chapman, et al., 2012; Sammons, 2012).

A key function of an education system is to improve learning and promote equity, which requires attention at the classroom level (Fullan, 2010). A deeper understanding of effective practice in relation to mathematics teaching will present a more hopeful, nuanced and contextualised picture of instruction in L&MIC and evidence for what good can look like to inform policymaking. However, data quality in L&MIC does not adequately allow for a SEIR lens with donor funded evaluations focused at the household rather than school level (ASER-Pakistan, 2015). My research considers how a pragmatic approach to SEIR can translate to the L&MIC context by utilising aspects of its methodology to explore the differences in instructional practices in a small subset of LCPS-schools.

SEIR applies as much to private as it does to government schools. The need to understand what is happening in the large, unregulated LCPS is essential. Then

comes the task of supporting it to deliver better learning-outcomes, particularly for the poorest. This thesis aims to provide evidence for policymakers to do this by seeking to understand what good practice in LCPS-schools in Karachi is like.

My rationale for studying mathematics teaching is to help promote improvement in education in Pakistan and contribute to policymaking in the field of pedagogy generally and in the LCPS in particular. The academic rationale set out above leads to the following research question: What is mathematics teaching and learning like in Karachi's LCPS primary schools? In order to answer this question, I will explore the following related four sub-questions:

RQ1. Who are the students attending Karachi's LCPS-schools?

RQ2. What values underpin teachers' instructional and professional practices?

RQ3. What instructional practices do teachers use to teach mathematics?

RQ4. How does the institutional environment support (or hinder) the development of mathematics teaching practice?

1.5 Overview of the thesis

In this chapter I explained the context and rationale for this research.

Chapter 2 provides an overview of the literature on the importance of teaching in improving learning-outcomes, the need for research which provides more detail at the classroom level and the instructional practices which improve mathematics learning-outcomes in HIC and L&MIC such as Pakistan.

Chapter 3 sets out my research methodology, which is a mixed-methods, case-study approach exploring instructional practices in five pilot and two in-depth LCPS-schools in Karachi. I used secondary quantitative data to describe the student population and primary qualitative data, including lesson observations and teacher interviews, to research mathematics teaching in these schools.

Chapter 4 presents my findings beginning with the characteristics of the student population, the values that underpin teachers' instructional and professional practices; the instructional practices they use in mathematics lessons; and the

institutional environment that supports or hinders the development of their practice.

Chapter 5 is a discussion of my findings in relation to the literature.

Chapter 6 sets out recommendations based on my findings and considers implications for my professional practice and policy implications for governments and donors. It concludes with consideration for future research.

Chapter 2 Literature review: Teaching and learning in low- and middle-income countries

2.1 Introduction

This chapter examines the literature in order to answer my research questions, working towards a theoretical framework for analysing teaching and learning in Karachi's LCPS-schools. This chapter focuses on two sub-questions most pertinent to teaching and learning practices: what values underpin teachers' instructional practices and what are effective instructional practices. I focus on effective teaching practices in order to compare the theory with empirical findings in my case-study schools. (I will use empirical findings to consider who my students are and the institutional environment that support or hinders mathematics teaching.)

Educational research in L&MIC focuses predominantly on system level issues with little detail of effective teaching and learning practices that are usable by practitioners and policymakers (Duflo, et al., 2012; Piper, et al., 2018). Research at the classroom level is needed to improve teaching and hence learning in L&MIC, particularly through exploring what good teaching looks like. I draw on HIC literature as that is where most teaching research originates from. Where available I draw on L&MIC literature and literature located in the LCPS, particularly from Pakistan and India because of the common origins of the two countries.

Throughout the chapter, where applicable and evidence is available, I exemplify generic findings with evidence from mathematics teaching in HIC and L&MIC.

Section 2.2 considers the link between teaching and learning in L&MIC, and the impact of the variability in teaching on learning. In order to contextualise this study, I explore L&MIC and LCPS teacher characteristics. Section 2.3 considers the definition of teaching and how concepts of pedagogy inform it. Section 2.4 uses the definition of teachers' knowledge bases to develop a theoretical framework articulating the features of good teaching in general and mathematics teaching in particular.

2.1.1 Definitions

The literature uses words such as quality/accomplished/expert/skilled to describe good teaching. I will adopt the definition of 'good' teaching which alludes to the instructional practices and principles that enhance or deepen student learning recognising that effective instructional practices are not just in relation to its outcome but also to its process (Rincon-Gallardo & Fleisch, 2016). A narrower definition, located in process-product research, defines teaching as 'effective' if it leads to high achievement by students in valued outcomes such as test scores after controlling for their starting points (Coe, et al., 2014).

Achievement, standards and scores are used to describe the learning levels of students. I am going to use the term 'learning-outcomes' as it provides clarity. I will use the general term 'outcomes' to refer to wider aspects such as students' personal development, retention and transition.

In describing the location of countries, I will use the World Bank's (2018b) HIC and L&MIC classification because I judge it to be a less subjective measure. Pakistan, like India, is defined as a lower-middle income country.

2.2 Teaching and teachers in L&MIC

I begin by considering the importance of teaching and how variability in its quality impacts on students' learning-outcomes. I then explore the context in which LCPS teachers work in comparison to government school teachers.

2.2.1 Improve teaching to improve learning

Teaching quality is widely recognised as the most important determinant of student learning-outcomes in both HIC and L&MIC (Hanushek, et al., 2018; Kyriakides & Creemers, 2009; Hattie, 2003). Evidence from L&MIC shows that improving teaching, focusing on what a teacher does and what she believes, is the most effective way of improving students' learning-outcomes (UNESCO, 2005; Aslam & Kingdon, 2011; Singh & Sarkar, 2012). However, across the world substantial variation is found in the value teachers add to their students' learning-outcomes (Hanushek, et al., 2018). In a longitudinal study of over 12,000 children covering Ethiopia, India and Vietnam, researchers identified

large differences in attainment of children at age eight, despite the fact that at age five they had similar starting points, suggesting that as well as contextual factors teaching effectiveness may be at play (Rossiter, et al., 2018). A Pakistani study of over 1500 government and nearly 1000 private school teachers found the difference between a less and more effective teacher is equivalent to more than one additional year of schooling (Evans & Yuan, 2017; Bau & Das, 2017).

Features of ineffective teaching are well documented in L&MIC: low levels of student/teacher interaction, lack of challenge, frequent use of criticism and negative feedback, and lack of vision (Coleman & Earley, 2005; Day, et al., 2014).

Although evidence is beginning to emerge relative to HIC much less information is available on which aspects of teacher quality matter in L&MIC and even less about how teachers perform along these aspects (Bold, et al., 2017; Hanushek & Woessmann, 2007; Piper, et al., 2016). The 'ingredient analysis' of successful interventions has not focussed enough on teaching and not identified the combination of teaching and learning factors that have the most effect (Piper, et al., 2018). There is consensus on the need for more research on pedagogical practices at the classroom level (Thomas, et al., 2012; Westbrook, et al., 2013).

I start by exploring the context in which LCPS teachers work, their professional characteristics, and how this compares to government teachers. I consider factors such as teachers' qualification, experience and effort, measured in the literature using the proxy indicator of attendance.

2.2.2 The context in which LCPS teachers work

While some researchers cite teaching in Pakistan as an acceptable profession for women (Andrabi, et al., 2013) others report it to be a profession of last resort (Shiraz & Qaisar, 2017). Regardless, the pool of talent for teachers is low. The LCPS thrives on the availability of poorly qualified and untrained teachers, often having just completed secondary education, willing to work for low pay (Andrabi, et al., 2013). Pakistani government teachers earn, on average, five to seven times GDP per-capita whereas private school teachers earn one fifth of their

government counterparts (Bau & Das, 2017). A national large-scale survey in Pakistan found 27% of teachers in Pakistan's urban private schools had no teacher qualification compared to less than 3% of government schools (ASER-Pakistan, 2015).

Teachers' observable characteristics, globally and in Pakistan, such as qualifications, training, certification, attendance and pay have shown little correlation with students' learning-outcomes in most subjects (Bau & Das, 2017). Improbably, teachers with higher qualifications do not produce better student learning than teachers with lower qualifications (Aslam & Kingdon, 2011; Singh & Sarkar, 2012; Hanushek, et al., 2018). However, for mathematics the picture is more mixed, teachers' possession of a higher degree or better class of mathematics degree is associated with more student learning, but the same relationship is not found in other subjects (Askew, et al., 1997). In the Indian context teachers with a diploma in education were found to have a significantly positive effect on mathematics results (Singh & Sarkar, 2012).

Teachers' knowledge is constructed in the context of teaching, as they gain experience their knowledge base increases (Rowland, et al., 2009; Wilson, 2013). Evidence from Pakistan indicates teacher effectiveness increased with experience in the first two years of teaching and was more pronounced in mathematics (Bau & Das, 2017). However, this effect diminishes over time with some teachers becoming less effective later in their career (Hanushek, et al., 2018; Chingos & Peterson, 2011). After three years no effect on learning-outcomes was evident between less and more experienced L&MIC teachers (Bau & Das, 2017).

Teachers' attendance is an issue in L&MIC (Chaudhury, et al., 2006). From a nationally representative sample of Indian government primary schools, researchers identified teachers were missing for half their scheduled teaching time (Kremer, et al., 2005). Reducing this resulted in significant increase in students' learning (Duflo, et al., 2012). A seven-country, 5000 teacher, African study finds similar absence rates and notes this is significantly higher in poorer areas with headteachers, male teachers and better educated older teachers more likely to be absent (Bold, et al., 2017). Responding perhaps to parental

pressure, teachers' absence was lower in areas with higher proportion of literate parents; and private school teachers and those living locally to the school had fewer absences than government teachers. Similar findings are noted in Indian LCPS-schools context (Singh & Sarkar, 2012). The authors purport this is because teachers had to travel less. An alternative argument is that of 'teacher-environment fit' with local teachers more invested in their own community and more accountable to their school and students (Atherton & Kingdon, 2012).

The high absence rates in government schools, tolerated and even contributed to by policymakers through non-teaching demands on teachers, suggests why private schools with higher accountability mechanism are an attractive option for parents. A global LCPS literature review found recurring evidence of greater monitoring of teachers' attendance and greater retention of better-quality teachers (Day, et al., 2014), findings replicated in Pakistan's LCPS (Aslam & Kingdon, 2011).

2.2.3 Summary

Stark differences between government and private school teachers across L&MIC include: 90% versus 22% receive training; 51% versus 26% are graduates; 2.6 versus 1.9 days absences per month; and 27% versus 54% live locally respectively (Bau & Das, 2017). Although the picture is more mixed in other parts of the world, in Pakistan (Andrabi, et al., 2009) and India (Sandefur, 2012; Mcloughlin, 2013; Day, et al., 2014; Muralidharan & Sundararaman, 2015), despite the differing characteristics and lower per-student costs, LCPS-schools improve students' learning-outcomes more than government schools. This suggests an examination of LCPS teachers' classroom practice which may contribute to these outcomes is worth exploring (Palardy & Rumberger, 2008). Next, I consider what teaching is and its relationship to pedagogy.

2.3 Teaching and pedagogy

I consider definitions of teaching and locate this in the wider discussion of pedagogy because teachers' beliefs and values inform how they teach and the expectations they will have of their students.

2.3.1 Defining teaching

A child working on their own does not do as well as when working with a person who knows more about the task (Vygotsky, 1986). It is teaching that bridges the knowledge gap between the student and the teacher. Alexander (2008, p. 77) expands that 'teaching has structure and form; it is situated in, and governed by, space, time and patterns of student organisation; and it is undertaken for a purpose'. I explore the space, time and organisational aspect through empirical study but here I reflect on the structure and form of teaching.

Regarding teaching as a science means regarding it as knowable, rational and subject to principles. It can be learnt and so it can be taught and building on experience it can be improved (Woods, 1996). This approach lends itself to a market ideology, to explanations and tools, and an accountability framework based on student learning-outcomes. This view of teaching conceptualises it as a complex cognitive skill characterised by pedagogical reasoning: a process of transforming teachers' subject knowledge into pedagogically powerful forms, adapted to suit the variation and ability of students.

Regarding teaching as an art attends to the characteristics that require emotion, imagination, ethics, instinct and swift judgement to address constant flow of issues and problems arising in the classroom. This viewpoint sees teaching as an 'improvisational performance' where the teacher, starting with a general outline of her lesson, draws upon an extensive repertoire to respond to her audience (Borko & Livingston, 1989). Viewing teaching as a craft, meshing its scientific and artistic elements, recognises it as a complex set of skills learned from study, training and experience. It recognises the physically, emotionally and cognitively demanding nature of teaching and the 'issues of moral purpose, emotional investment and political awareness, adeptness and acuity' that inform it (Woods, 1996, p. 31).

Teaching is all of the above (Hunter & Hunter, 2004). The art informs the scientific theory, promoting good practice in an evolving, contextualised way, enabling principles of effective teaching to be articulated, informed by theory. These principles provide a vocabulary with which to discuss teaching and a

framework for professional practice which supports in the endeavour to improve its quality.

Teacher effectiveness research in HIC focuses on the measurable behaviours which have an impact on student outcomes (Muijs, et al., 2014). In the absence of work grounded in L&MIC, HIC literature provides a foundation against which to compare practice in the former. However, teacher effectiveness discipline does not engage with purpose, meaning and messages that drive teachers' behaviours. Next, I locate teaching in the wider discourse of pedagogy which does considers this, seeking to understand why teachers do what they do.

2.3.2 Defining Pedagogy

In this section I consider the purpose of teaching and how pedagogies, such as autocratic and transformative, reflect differing meanings and purposes which inform teachers' actions.

Instrumentalists define effective teaching as organising classroom time and space as economically as possible, maximising children's opportunity to learn, and generating challenging and focused student-teacher interaction (Reynolds, et al., 2002). Here the knowledge-base for effective practice comprises the interaction of knowledge about subject-matter, pedagogic approaches, and children and their development (Husbands & Pearce, 2012).

Pedagogy is a complex idea which unpicks the power relations, social control and institutional mandates which inform what teachers do. I am influenced by Alexander's (2008, p. 4) articulation of pedagogy as 'the act of teaching together with the ideas, values and beliefs by which that act is informed, sustained and justified'. Waring and Evans (2014, p. 29) expand the definition to that which 'celebrates the fundamental and integrated relationship between theory and practice' extending to the political sphere by promoting social justice and equity. This is pertinent in the context of my research which focuses on underprivileged children taught by poorly paid and inexperienced teachers.

The pedagogy discourse coalesces into three levels (Alexander, 2000): Pedagogy at *classroom level* is about ideas that enable teaching: what is to be

taught, to whom and how. It considers the nature of learning, how to facilitate and measure it; the nature of teaching, its planning, expectations and evaluation; and it includes the curriculum (Alexander, 2000).

At the *system and policy* level are the ideas that formalise and legitimise teaching such as the policies and practices that enable or inhibit what is taught and how. Finally, pedagogy at the *culture and society level* locates teaching in time and space. It is informed by community and familial attitudes that shape teachers' work, and students' outlook and concept of self, which are also shaped and acquired through education (Kyriakides & Creemers, 2009). Society informs the differing concept of schools, for example, as gardens growing children, factories making children or as hospitals curing children of ignorance (Watkins & Mortimore, 1999).

Autocratic pedagogies, with teacher decisions controlling the content, pace and task, relies on her dominance and the students' dependence. The dominance is too often exerted through inducing fear rather than negotiated based on the teachers' expertise or more transformatively legitimised through consultation with students. The fear-promoting authority can be asserted through verbal and physical punishment or more subtly through inducing fear of causing disappointment. In contrast, transformative pedagogy organises and disorganises students' understanding of the natural and social world through the 'agentic interaction of the teacher, the student and the knowledge they produce together' (Zyngier, 2016, p. 177). It demands the acknowledgement of culture in school as a social and political issue of power and struggle between class, gender, race and ethnicity. Transformative pedagogies legitimise and value the culture students bring and promotes self-sufficient identities, committed to collective as well as individual empowerment.

2.3.3 Summary

When exploring teaching what happens outside the classroom is as important as what happens in it as this influences the decisions and choices teachers make. Given the site of this research is the poor who have limited social capital and limited experience of schooling, teachers' expectations and views of their

and their students' role will inform the pedagogies they adopt and consequently students' outcomes.

Next, I consider the components of effective teaching and expand further on the pedagogies that underpin these teaching approaches.

2.4 Towards a framework for defining good teaching in L&MIC

I set out, using Shulman's (1986) framework, what the literature says about teachers' knowledge base and use this to develop a framework characterising features of good mathematics teaching in order to explore LCPS teachers' practice.

Pring's (2001, p. 23) articulation of teaching as a 'conscious effort to bridge the gap between the state of mind of the learner and the subject matter which is to be learnt…and as such the teachers' expertise lies in understanding both' narrows Alexander's definition. Shulman (1986) articulates seven categories of teachers' knowledge base in two interlinked knowledge types. The first is pedagogical knowledge comprising: knowledge of educational *goals, purposes and values;* knowledge of *educational contexts* (ranging from the working of the classroom to the character of communities and cultures); knowledge of *students* and their characteristics; and *general pedagogical knowledge* (classroom management and organisation). The second is subject content knowledge comprising: *content knowledge* (the structures of the subject, substantive and syntactic); *pedagogical content knowledge* (how to represent the subject in order to make it comprehensible); and *curricular knowledge* (set out in sources such as schemes of work, textbooks and the national curriculum).

There are substantial differences across countries in teachers' propositional structures (knowledge about students, subject and pedagogy) that are strongly related to students' learning-outcomes (Hanushek, et al., 2018). In mathematics, teachers' pedagogical reasoning, characterised by their pedagogical and subject knowledge system, improves as they develop schemas in relation to three aspects: scripts for teaching; scenes representing their knowledge of classroom events; and propositional structures (Borko & Livingston, 1989). Effective teachers have 'stores of powerful explanations,

demonstrations, and examples of representing' mathematics to students which ineffective teachers lack (Borko & Livingston, 1989, p. 490).

I begin developing a framework for teaching by considering Shulman's first two knowledge categories together.

2.4.1 Knowledge of educational goals, purposes and values; and contexts

This research is focused on the teaching experienced by students who were previously out of school. This heightens the equity dimension of their schooling. In this section I consider how issues of inclusion and equity inform experiences of schooling and contribute to the development of students with the understanding, skills and values they need to function (Shulman, 1987).

Schools are an exercise of power between adults and students enacted through a disciplinary system that directs what, when and how they learn which in turn affects their experience of childhood. Schools 'shape children's experience of who they are and what they will become' (Devine & McGillicuddy, 2016, p. 424).

Rather than transforming poor students' opportunities, schools, whether in HIC or L&MIC, can be institutions that replicate and perpetuate inequalities found in wider society. Children experience inequality of opportunity in accessing quality education; inequality of experience in their pedagogic interactions with teachers; and inequality in outcomes which are well-documented (World Bank, 2017; Unterhalter, 2015).

Unterhalter's characterisation of three inequality metaphors is helpful in developing an understanding of these. Viewing inequality as *crossing a line*, the intention is to get everyone to the same basic minimum level. This ignores the vertical and horizontal systemic inequalities such as poverty that exclude groups from crossing the line in the first instant. In considering inequality as an *interconnecting mesh*, schools may contribute to and reproduce the inequalities seen in society, for example, in the denigration of the child's home language, prejudices about parental background and assumptions about children's ability. Finally, is the concept of *inequality as a fuel* powering social movements and change, exposing inequitable practices, seen in the activism of outliers driving

change for other members of their group (Zyngier, 2016). Unterhalter (2015, p. 147) argues that to address systemic, persistent inequalities, the goal of education must be to shift inequality 'cognitively, pedagogically and emotionally'.

The demands placed on teachers, and the business and complexities of their professional lives, may leave little space for them to consider their purpose in addressing these concerns. In a 12-school study based in Ireland involving nearly 80 teachers, the researchers find discourse on the concept of social justice, equality or children's rights did not emerge and so teachers' understanding of their roles in enacting transformative, productive, culturally relevant pedagogies was not evident (Devine & McGillicuddy, 2016; Zyngier, 2016). Others have found similar tensions in L&MIC (Unterhalter, 2015).

Evidence from HIC highlights that teachers' expectations of their students are one of the most important and consistently significant factors in teacher effectiveness. Simply, students of high-expectation teachers achieve better results (Muijs, et al., 2014). Effective teachers of underserved students enact inclusive, transformative pedagogies based on a deep-seated belief that all children can be successful. These teachers foster critical perspectives in their students, nurturing their cultural identities and utilising their existing funds of knowledge (Bonner, 2014). However, studies in the context of mathematics as well as mathematics in L&MIC are rare.

2.4.1.1 Expectations in mathematics

Teachers' perceptions of a student as a learner and whether they can go beyond their zone of proximal development (ZPD) depends on the environment that teachers create for them (Murata, 2015). This distance can be closed rapidly but is subject to the teacher's view of their own and their student's role in learning, and in the expectations of their students. The 'ethic of everybody' places the responsibility on the teacher to design their teaching in a way that enhances everyone's learning (Hart, et al., 2004).

Studying effective mathematics teachers in the UK, Askew et al (1997) argued that teachers' beliefs about the nature of mathematics and how children learnt

it, and their responsibilities as teachers in presenting mathematics in an accessible way impact on whether students achieved success in the subject or not. Effective mathematics teachers believe that almost all children can be numerate and intervene when children face difficulties.

Expectations inform the pedagogies teachers utilise. In a small, in-depth case-study of three US schools identified as having high impact on underserved children, Bonner (2014) explored the key ingredients of culturally responsive mathematics teaching. She concluded that these schools were successful because they emphasised three interrelated concepts of *trust* mediated through *communication* and *knowledge* about students. Bonner argues for connecting with students' lived experiences in order to 'mathematise' these, using instruction as a tool to help students understand contexts and experiences including those 'that lead to and maintain marginalisation'. These teachers supported students to experience academic success while maintaining their strong racial and cultural identities. Lessons intertwined discipline with pedagogy that fluidly shifted power between teachers and students supporting the latter to aspire to the expectations of the former. These teachers exhibited 'warm-demander' 'tough-love' pedagogy creating a structured and disciplined environment for students whom 'society had psychologically and physically abandoned' (Bonner, 2014, p. 395).

Making a case for developing students' advanced thinking skills in high-poverty classrooms, Knapp et al (1995) undertook a large-scale study of 140 high-attaining US primary schools serving predominantly low-income students. Instead of tightly controlled instructions focused on basic skills and ability groupings, they found high-attaining high-poverty classrooms were predominantly characterised by an emphasis on meaning-orientated instruction. Their instructional practices supported students to perceive the relation of parts to the whole; provided tools that help students construct meaning; and instruction that explicitly connects different subjects.

Effective teachers are explicit in learning about, and connecting learning to, students' home life. However, several studies note that the connection between classroom mathematics and its relevance to real life is often not made, with few

practical exercises to develop L&MIC students' conceptual understanding (Piper, et al., 2016; Coleman & Earley, 2005; Singh & Sarkar, 2012).

In mathematics meaning-making is emphasised through developing conceptual understanding and expanding the breadth of the curriculum; presenting students with complex non-routine problems; and promoting multiple-solution approach to problem-solving enhanced with discussion of alternate approaches (Knapp, et al., 1995). However, teachers less expert in creating an enabling environment struggled to manage behavioural aspects of this teaching approach. Rather than a dramatic departure, it should be seen as an expansion of teachers' repertoire to incorporate greater academic challenge for students through exposure to a wider, more relevant curriculum. This type of instruction supports poorer children, particularly in addressing the cultural discontinuity experienced between their home and school life.

Teachers need to be aware of the contrast between their own culture and society, which informs their individual pedagogy, and that of their students, and enact reciprocative pedagogies that translate students' everyday world to the school world (Zyngier, 2016). Arguing against a western perspective of pedagogy in Australia, Zyngier suggests that in valuing what students bring to the school more needs to be done to integrate indigenous and school knowledge by using local languages and resources, stories that develop students' cultural identities and incorporating spirituality into education. Zyngier posits that it is difficult for teachers to differentiate between the two worlds in order to move from instrumentalist pedagogies to more productive pedagogies. Consciously seeking to invite students' views and valuing their culture creates a sense of belonging and community in the co-constructing, facilitative tradition of teaching and helps bridge the gap (Affouneh & Hargreaves, 2015).

Tensions exist between productivity which values performance and pedagogies which value children (Devine & McGillicuddy, 2016). While officials and parents demand greater performance, the role of teachers is also to nurture children. Subsequently, there can be dissonance between how teachers think about and how they practise pedagogy. In an Irish study, pedagogies which promoted higher order meta-cognitive skills in middle-class schools were evident while

active learning strategies were promoted in working-class schools. However, the higher the proportion of immigrant children in the class the less evidence of active engagement there was and the more grouping by ability with its attendant labelling. Lingard (2007) describes these as ‘pedagogies of indifference’, not related to the care teachers show but rather the limited difference they make to learning-outcomes due to lower expectations resulting in lower cognitive demands of poorer students. The caring dimension sapped teachers’ energy from effective instructional practices.

Next, I consider the knowledge teachers need to have of their students and how they use it to adapt their teaching.

2.4.2 Knowledge of students and their characteristics

Student characteristics vary based on a school’s location and even in homogenous populations, groups and individuals within a class vary. However, it is difficult to ascertain the characteristics of the children attending LCPS-schools from the literature as this tends to focus on parents’ characteristics.

In an extensive literature review Day et al (2014) conclude that evidence on the ability of the poorest to afford LCPS-schools is ambiguous with a very small number of studies suggesting a small minority do use them. Estimates from a 12,000-student quantitative study in rural Pakistan suggests 18% of the poorest third send their children to LCPS-schools, finding that fees of around 200Rs (£1.08) per month are affordable to some of the poorest (Andrabi, et al., 2009). Using quantitative research with a sample of over 1,650 Pakistani households, Alderman et al (2001) report a monthly household income of 2000Rs (£10.80) will likely result in children being sent to a LCPS-school in response to parental assessment of its higher quality. Poorer parents offset the burden of fees by sacrificing in other aspects and undertaking substantial borrowing (Day, et al., 2014).

2.4.2.1 Students of mathematics

Mathematics elicits emotive, polarised views in children and adults (Ali & Ried, 2012). Terms like ‘mathematical trauma’ describing the experience of learning mathematics underline the strong emotions associated with it (Boaler, 2016).

Rather than the concept of innate mathematical ability, a US study working with 40 teachers asserts that mathematics is a subject like any other with mathematical pathways in the brain developed and mastered through effort and practise (Anderson, et al., 2018). Building on Dweck's (2006) work, the authors challenge the 'maths person' myth. They propose developing a 'mathematical mindset approach', promoting the concept of students as self-regulated learners, supporting them to acquire understanding of their cognition, meta-cognition and motivation. Evidence from HIC suggests that promoting meta-cognition in students can compensate for limitations in initial cognition and has a positive impact on performance (Muijs, et al., 2014). Teachers who themselves have and train their students to have a growth mindset, believing that intelligence can grow and change, were found to have higher student performance, enjoyment and engagement of mathematics (Boaler, 2016).

Echoing this, in a Pakistani study of 800 primary school children, researchers found children's self-efficacy, defined as a students' judgement of their capability to solve the mathematics problems posed to them, was a significantly positive predictor of achievement in mathematics (Anjum, 2006).

2.4.2.2 Adapting teaching to meet the needs of students

Teachers need to adapt and tailor the subject content to the characteristics of their students. Adaptation focusses on the students in the teachers' classroom whereas tailoring pays attention to particular groups and individuals within the classroom (Shulman, 1986).

Proponents of transformative pedagogies argue students already receive differentiated education based on poverty, class, race and ethnicity (Zyngier, 2016). Therefore, their achievement should be defined by their effort rendering it unacceptable to predetermine students' ability or capacity to learn. Due to cultural discontinuity, deprivation, iniquitous experiences and opportunities, many children are not able to access higher levels of learning, particularly those previously out-of- school. Shayer (2003) suggests that in a typical classroom only around 20% of children are likely working at their true mental potential but through teaching children's cognitive levels can be increased enabling them to access higher levels.

Focusing on empirical research based on mathematics and science, Shayer (2003) advocates for instruction that accesses the current mental level of each student in order to enable them to access the cognitive demand of the task set for the class. Identifying that through interaction with peers a communal ZPD is created which extends and exceeds an individual students' ZPD, Shayer forwards an inclusive pedagogy for teaching. Providing a theoretical underpinning of the importance of classroom discussion, he suggests exchanging ideas and mediating each other's input enables students to witness and internalise learning.

Next, I consider what the curriculum entails students should learn in mathematics.

2.4.3 Curriculum knowledge

The curriculum sets out the scope and sequence for what students should learn, articulated in national curriculums, textbooks and examinations and contextualised in schools' and teachers' plans.

Students in mathematics need to gain proficiency in three main areas: procedural fluency gained from factual knowledge; conceptual understanding of the factual knowledge; and strategic competence in using both to solve new problems efficiently (Donovan & Bransford, 2005). This requires explicit teaching of each area, with students learning different approaches to solving problems and the skills to discern the most efficient methods, articulating their rationale and approach.

An *instrumentalist* view of mathematics sees it as an accumulation of unrelated but utilitarian facts, rules and skills to be imparted to students; whereas *Platonist* sees mathematics as immutable with the various aspects working together relationally, developing an understanding of what makes it work. The *problem-solving* view holds mathematics as dynamic, expanding and ever changing, creating patterns and further knowledge (Amirali & Halai, 2010). These three traditions can be seen as hierarchical. The problem-solving view sees teachers' valuing different ways of working out a problem, welcoming

errors and working through them, scaffolding to support students to attain mastery (Anderson, et al., 2018).

Next, I consider the content knowledge mathematics teachers themselves need to have before they can teach it.

2.4.4 Content knowledge

Shulman (1987, p. 14) argues that 'to teach is first to understand' critically engaging with what is to be taught and to whom, relating content within and across subjects, and to the purposes of education.

Teachers' anxiety about their ability to do mathematics can get communicated to students, creating a vicious circle, and has been found to lower the achievement of girls in particular (Boaler, 2016). However, in a study of 200 government and private sector mathematics teachers in Karachi, Amirali & Halai (2010) find that teachers report enjoying mathematics. This suggests that other factors contribute to the low mathematics learning-outcomes.

Teachers' content knowledge has a large and significant effect on student performance with around 20% of the gap in student learning across high and low performing countries explained by the gap in teachers' knowledge (Bold, et al., 2018). Mathematics content knowledge consists of substantive knowledge about facts, concepts and processes of mathematics and the links between them, and syntactic knowledge regarding how mathematical truths are established and the processes of doing mathematics, such as proving and disproving (Rowland, et al., 2009).

Measuring mathematics teachers' content knowledge is a better indicator of their effectiveness than other measures (Hill, et al., 2005). Pakistani teachers' higher mathematics knowledge was found to be significantly correlated with higher value-added scores of their students (Bau & Das, 2017). Findings from a study of nearly 3,000 mathematics teachers in the US indicate that students exposed to teachers with higher content knowledge learn more because: they provide better mathematical explanations; present mathematical ideas more

clearly; make connections explicit; and through listening to students support their contextual understanding more effectively (Hill, et al., 2005).

As students get older and the mathematics they learn more demanding, the relationship between their socio-economic status and teachers' content knowledge was found to be significant in its inequitable distribution (Hill, et al., 2005). More disadvantaged students had teachers with less content knowledge and intellectual resources.

Teachers in L&MIC often lack the knowledge and skills required to improve learning-outcomes, having weak content knowledge themselves and ineffective pedagogical skills (Bold, et al., 2017; World Bank, 2018c). In a 5000 teacher, seven African country study, only 11% of teachers had the minimum required pedagogical knowledge. For mathematics, almost a quarter were not able to subtract double digit numbers, one third not able to multiply them and only 15% able to solve a mathematical word problem (Bold, et al., 2017).

A study of 1800 Pakistani teachers found the average mathematics score to be 39% for males and a much lower 23% for females (Saeed & Mahmood, 2002). The authors cite inadequate facilities for the low results of teachers but do not articulate why this has a more dramatic effect on female teachers. In a 12-school Pakistani study, Mohyuddin and Khalil (2016) identify teachers' confusion about basic mathematical concepts including place value, measurements conversions and relationship between variables in line graphs. However, these findings are not robust as the study was not purposively designed to assess teachers' knowledge.

A study aiming to develop teachers' relational over instrumental understanding in a high-fee Pakistani private school, posited that the teachers' insufficient mathematical knowledge resulted in their unwillingness to undertake a questioning style which might expose this (Halai, 1998). The teachers viewed mathematics as fixed with single, infallible step-by-step procedures not necessitating discussion or multiple responses.

2.4.5 General pedagogical knowledge

I turn next to general pedagogical practices that transform teachers' knowledge into forms that students can access. I analyse key HIC teaching frameworks seeking to define how pedagogical knowledge manifests itself in practical terms in the classroom. Collectively the number of components in these frameworks signal the complexity of teaching and the multiple, simultaneous demands placed on teachers.

Noting that some instructional practices are more effective than others, Hunter's (2004) model stipulates four domains: preparing students to learn; presenting information clearly and explicitly; checking for understanding and guiding practice; and facilitating independent practice.

Danielson's Framework for Teaching (2007) also has four domains: planning and preparation; the classroom environment; instruction; but, unlike Hunter's, considers teachers' wider professional responsibilities. Rosenshine (2012) bases his ten Principles of Instruction in theories of learning, drawing on empirical evidence. The Classroom Assessment Scoring System (CLASS) is of interest because it has been tested in L&MIC (Pianta, et al., 2008). It identifies three domains: emotional support provided by the teacher, classroom organisation and instructional support.

While giving prominence to teaching, Creemers and Kyriakides' (2011) Dynamic Model is a more comprehensive, multi-level, model paying attention to school as well as the wider educational system and policies. It has eight components: orientation, structuring, questioning, modelling, application, the classroom learning environment, management of time and assessment.

The main components of these generic teaching frameworks can be summarised in five stages: planning and preparation in the pre-lesson stage; classroom environment and instructional practices, both in-lesson stage; independent practice and summative assessment, both in- and post-lesson; and teachers as professionals with wider responsibilities outside of direct teaching. There is an overarching prominence given to communication across the

models. I discuss each next, exemplifying in reference to mathematics teaching where relevant.

2.4.5.1 Planning and preparation

In this phase, teachers are expected to demonstrate knowledge of content, pedagogy and resources. Informed by knowledge of students' prior learning and experiences, teachers set instructional outcomes, design coherent instruction matched to students' needs, and activities to assess how well students have acquired the instructional objective. This is particularly important in subjects such as mathematics where misconceptions established at an earlier stage create barriers to understanding new learning (Husbands & Pearce, 2012; James & Pollard, 2011).

In L&MIC the formal curriculum expects a far higher cognitive demand than present in many students (J-PAL, 2013). However, matching the instructional level to students' starting point is known to be consistently effective in improving learning quality (Glennerster, 2013).

Although a small-scale study of eight US teachers, Borko and Livingston's (1989) study of expert and novice mathematics teachers is illuminating. Expert mathematics teachers anticipate the cognitive difficulties students will have in their planning and the areas of mathematics these misconceptions will affect. Consequently, they pre-emptively address these. The automaticity expert teachers gain through experience enables them to plan quickly, react speedily improvising within lesson, and focus on issues most pertinent to the lesson objective. Novice mathematics teachers, in contrast, adhere to their script, unable to adapt and respond to students' unexpected questions. They are also less able to select the most important cues to students' understanding.

2.4.5.2 Classroom environment

The environment is about the classroom culture in general, irrespective of the subject, which aids or inhibits learning (Hargreaves, et al., 2017). Learning opportunities are created when teachers enable an efficient environment, minimising behavioural related issues and maximising instructional time. A fearful environment created by teachers' verbal intimidation hinders students'

ability to learn. Children in a two-school Palestinian study described its effect as reducing their 'power of acting and reasoning, reflecting critically and engaging in critical dialogue' (Affouneh & Hargreaves, 2015, p. 232). In another single-school study in England, students articulated how positive or negative feedback, including approval or withdrawal of it, elicited emotions that hinder or support their learning (Hargreaves, 2013a).

Factors students identified in helping them to learn best arise when they experience enjoyment, particularly where their creativity and personal perspectives are valued, and they have an opportunity to talk to each other 'when the teacher is not talking too much' (Affouneh & Hargreaves, 2015, p. 234). In a study involving nearly 400 students in three Egyptian primary schools, students reported they value a calm, humorous and fair teacher, one who smiles and is willing to joke, signalling an ethic of care (Hargreaves, et al., 2017). These studies signal the importance of affective relationships as a foundation for cognitive development.

Rules, routines and rituals govern every aspect of students' school experience (Alexander, 2000). Muijs et al's (2014) literature review identified teachers who establish clear procedures and rules for student behaviour, explaining why they are important and rigorously enforcing them, involving students in the construction of these rules, provide the most opportunity for learning. As well as a transactional requirement of these rules, there is an emotive aspect to them.

If the students view the teacher's authority as legitimate then they accord her the right to command them and to have the commands obeyed (Hargreaves, et al., 2017). In Pakistani classrooms, as in Arab classrooms described by the researchers, this authority is bestowed from traditional as well as religious perspective, given the teacher is considered equivalent to a parent. The right to rule is often assumed by the teacher and the parents irrespective of the teacher's pedagogical expertise or skill in developing affective relationships (Hargreaves, et al., 2017). While the students in the study valued the teacher who keeps order and explains clearly, they accord legitimacy to the teacher based on the love and care they demonstrate. These teachers are emotionally and socially expert in navigating the tension between exerting authority and

practising productive pedagogy, distributing authority to students (Hargreaves, et al., 2017).

Having considered teachers' planning and the classroom environment, I turn to the instructional practices effective teachers use to enable their students to learn.

2.4.5.3 Instructional practices

In this section I explore five key components of instructional practices identified in generic teaching frameworks: lesson framing; direct instruction and scaffolding learning; formative assessment; questioning; all underpinned by communication, an overarching feature of effective teaching. Where relevant, I refer to or expand on mathematics teaching to illustrate the general point.

a. The importance of communication

There is agreement in the literature on the critical role language plays in effective teaching, irrespective of the subject, and the importance of teaching processes that are communicative, dialogic and cognitively demanding (Alexander, 2008; Westbrook, et al., 2013). In an extensive L&MIC literature review, Westbrook et al (2013) contend pedagogies that force interaction between teachers and students, demanding a visible response from them are more likely to be effective in terms of furthering students' learning.

Teachers exercise asymmetric control of what students learn, when and how (Lin, 2007). Their pedagogical repertoire is targeted in three ways: organising interaction talk (routine, disciplinary and supervisory); teaching talk (instructional, evaluative and supervisory); and students' learning talk which may or may not involve the teacher (Alexander, 2000; 2008). Effective teachers focus more of their talk on academic related matters rather than managerial or procedural ones (Muijs, et al., 2014).

Not much appears to have changed since Flanders (1970) quantified the asymmetry in classroom communication: two-thirds of talk is by the teacher and three-quarters of this is with individuals whereas three-quarters of the students' interaction with the teacher is as a class. An Indian study of 180 LCPS

classrooms found teachers dominated the classroom discourse even more, accounting for 78% of talk (Smith, et al., 2005). An English study articulated children's frustration when teachers shared answers which students could work out themselves or provided unnecessarily repetitive direction (Hargreaves, 2013b).

Teacher-led classroom dialogue is dominated by the triadic initiation-response-feedback/follow-up (IRF) exchange pattern (Sinclair & Coulthard, 1975; Smith, et al., 2005). This can limit students' opportunity to practise higher order cognitive skills resulting in convergent assessment situations (Hargreaves, 2013a). In the Indian LCPS study cited above, initiation accounted for less than 9% of lesson talk, with teachers asking mostly closed questions requiring a single word answer and hardly any probing questions (Smith, et al., 2005).

Feedback is, however, judged to have a powerful influences on learning as it addresses 'the gap between what is understood and what is aimed to be understood' (Hattie & Timperley, 2007, p. 82). Three levels of feedback in order of increasing effectiveness are about the *task*; about the *process* and about students' *self-regulation*. The fourth level is with respect to the *self*, which the authors argue is the least effective.

Teachers can make the IRF function more dialogic, facilitating student-to-student discussion and promoting higher level thinking, thereby expanding the learning space (Stahl, 1994; Muijs, 2010; Smith, et al., 2005). Dialogic teaching is a collective stance where the teacher and student address the learning process together, cumulatively building on their own and each other's ideas in a purposeful, unfearful manner. However, highlighting its complexity, Alexander (2000) lists over 61 classroom indicators for dialogic teaching.

Transformative pedagogies, informed by dialogic teaching, focus on improving unequal power relations by promoting students' critical reflection about learning and about their own situation. This stance requires the teacher's worldview of teaching to shift from the traditionally transmissive to negotiatory and facilitative, seeking to develop students' autonomy and criticality (Affouneh & Hargreaves, 2015).

Effective communication in mathematics teaching

A reflexive relationship exists between students' individual mathematics learning and their social setting (Murata, 2015). Arguing for a more collaborative learning environment with opportunities for discussion, reflection and sharing in collective problem solving, Murata suggests that the collective ZPD of the class is longer than individual student's, which helps the class learn through the stimulation provided by the diversity in individual differences.

Mathematical communication between students enables them to experience 'constant intellectual negotiation', making connections and deepening understanding (Murata, 2015, p. 237). For this to happen teachers need 'width of instruction' which demands students articulate their ideas. This is a space for conceptual development, allowing students' differing learning trajectories to interact with each other. There is likely to be between three to five different learning trajectories that teachers need to contend with arising from a 'few common patterns of mathematical thinking' (Murata, 2015, p. 10).

Expanding the width of instruction is a move away from convergent single-solution, single-method, right-answer mode of mathematical teaching towards divergent-discussion based mathematical experiences that build on students' reality outside of the school (Affouneh & Hargreaves, 2015). It incorporates students' differing ideas and methods, enabling them to experience uncertainty. Students who find school alienating are supported in linking formal mathematics to their own ideas, helping them to self-identify as learners in an academic context (Murata, 2015).

Even when teachers articulate the value they place on collaborative learning, this may not translate into their practice. In a small-scale study in Pakistan, despite selecting two mathematics teachers for their stated commitment to collaborative learning, in observations of over 20 lessons neither teacher demonstrated this or teaching strategies that sought to deepen students' 'internalisation of critical concepts' (Shiraz & Qaisar, 2017, p. 108).

Language demands in mathematics require attention to both semantics and syntax (Nag, et al., 2014). For example, unlike English, in Urdu numbers have

distinct names rather than a pattern and some names sound similar which adds to the literacy demands for students (Mohyuddin & Khalil, 2016). Mathematical language comprehension skills are also essential in relation to solving worded problems.

In summary, the above set out a challenging set of demands on the teacher to develop skilful communicative pedagogies that not only deepen conceptual knowledge but responds to the students as individuals seeking to develop them as autonomous beings, able to be critical about their learning and their lived contexts.

b. Lesson framing

The beginning of a lesson, the orientation phase, focuses students on the lesson objectives, helping them to identify the rationale for the lesson's activities (Creemers & Kyriakides, 2011). The teacher reviews past learning, revising key vocabulary, concepts and procedures to strengthen the connections between previous and forthcoming learning (Rosenshine, 2012). This contributes to 'over-learning', practicing beyond the point of initial mastery to achieve automaticity. Students in classes where mathematics teachers did this regularly performed better than classes where reviewing was absent (Rosenshine, 2009).

c. Direct instruction, scaffolding learning and guided practice

Student achievement is consistently linked to the quantity and pacing of instruction with achievement maximised when teachers focus on academic instruction and students' time on curriculum related tasks (Muijs, et al., 2014). Recognised as a high impact feature of teaching, direct instruction involves presenting information clearly and concisely using terms and examples familiar to students to further new learning (Muijs, et al., 2014).

Direct instruction is explicit systematic teaching. It includes scaffolding, guided practice and re-teaching to enable mastery (Rosenshine, 2009; Vignoles, et al., 2015). In a US study, effective mathematics teachers spent over half their lesson providing direct instruction whereas less effective teachers spent around a quarter (Evertson, et al., 1980). Effective teachers' lecture, demonstrate, explain, provide examples of increasing cognitive demands and ask more

questions to check understanding. In contrast, less effective teachers give shorter explanations followed by worksheets for students (Rosenshine, 2012).

Cognitive apprenticeship, scaffolding learning, facilitates a developmental change in students (Rosenshine, 2012). Effective teachers reduce the intrinsic cognitive load of content by breaking down tasks into small steps, providing step-by step-guidance by modelling how to solve problems (Clarke, et al., 2012). As students gain automaticity and mastery in teacher-supervised, whole-class guided practice, cognitive demand can be increased, reducing and removing scaffolds, and introducing new ones to take account of the updated cognitive state. Cognitive load theory is noted to be particularly relevant to subjects such as mathematics as it can often be divided into well- and ill-structured tasks that have explicit steps (Klahrl & Nigam, 2004).

Scaffolding involves the teacher making explicit her reasoning process by thinking out loud; providing worked and partly worked examples; emphasising common errors and misconceptions; and introducing parts of a complex problem before the integrated whole task (Sweller, et al., 1998). This provides students with problem-solving schemas which get stored in their long-term memory to be applied to new problems (Centre for Education Statistics and Evaluation, 2017). Egyptian primary school students when describing what helps them learn best noted the importance of the teacher explaining 'in a quiet and gradual manner', re-explaining as necessary, and not rushing onto the next topic before they had a chance to understand the current one (Hargreaves, et al., 2017, p. 10).

A Tanzanian study, of low- and high-performing schools, found that while in both school types mathematics teachers began the lesson with whole-class direct instruction, high-performing teachers utilised teaching activities such as questioning more quickly whereas their counterparts in low-performing schools continued lecturing for longer (Brombacher, et al., 2014). Teachers in high-performing schools spent double the amount of time asking and answering students' questions than teachers in low-performing schools. They also were more willing to interrupt seatwork to bring students together to respond to questions or address misconceptions, whereas less effective teachers engaged

at an individual level in conflict with cognitive load theory findings (Pouezevara, et al., 2016; Brombacher, et al., 2014).

d. Formative assessment

Using assessment effectively can have powerful impact on learning-outcomes, particularly of lower attaining students (Pritchett & Banerji, 2013). A key component of teaching is making judgements, seen both in *differentiation*, the extent to which activities are adapted to the differing needs of students, and in formative and summative *assessment*. Alexander (2000) argues that while both accompany teaching, differentiation precedes it and assessment follows it. However, formative assessment is an accompaniment of effective teaching (Hattie, 2008; Wiliam, 2011).

Formative assessment's goal is to foster autonomy and independence in students. It is achieved through considering lesson-planning as a 'privileged occasion for conscious reflection' for students and teachers (Hargreaves, 2013b, p. 238). Formative assessment has a continuum of practice ranging from assessment as measurement to assessment as inquiry. The former identifies and reports on the extent of learning whereas the latter focuses on how learning comes about, linking new and old learning with the teacher and student co-constructing this process (Hargreaves, 2005). The position on the continuum is informed by whether it is the teacher or the student who addresses the gap revealed by assessment feedback.

Black and Wiliam (1998) in a seminal HIC literature review reflected on the performance-measurement versus learning-inquiry orientation of students and highlight three key aspects. The first is the teachers' epistemological viewpoint informed by their view of learning potential being fixed or incremental. The second is the teachers' psychological perspective focused on the notions of what and how to motivate students to take on assessment practices and ownership of their learning. The final aspect is the teachers' pedagogical practice and whether they see themselves as the transmitter of knowledge or as co-constructers of it with students (Alexander, 2000). In each of the three perspectives, the latter informs the more effective learning orientation with students acting on feedback and benchmarking themselves against the subject

criteria (as opposed to their peers), taking control of their learning rather than being passive learners responding to teacher direction.

e. Questioning

Formative assessment requires regularly checking where students are in their understanding, providing immediate feedback and adapting teaching as a consequence. Effective teachers assess students' understanding through a variety of mechanisms: by planning and asking cognitively demanding questions; asking students to repeat directions and summarise key concepts; and making deliberate mistakes for student correction. Effective teachers ask factual, product-orientated questions as well as process-orientated open-ended ones, demanding students explain their methods and articulate their reasoning. Their questions vary cognitively and are more likely to demand procedural-explanatory responses from students rather than product-single responses (Muijs, et al., 2014; Wiliam, 2011).

Questioning takes students' learning from a low cognitive level of recall to higher levels of evaluation and synthesis (Bloom & Carroll, 1971). Combining lower with higher order questions is found to be the most effective method for generating learning for students of all ages (Cotton, 1988). In a 68 teacher US study, Evertson et al (1980) identified that effective mathematics teachers asked 24 questions during a lesson compared to the nine less effective teachers asked. Importantly they asked six, compared to the less effective teachers' one, questions which required students to explain their mathematical methods.

Drawing from an evidence base of 83 English primary schools, Vignoles et al. (2015) suggest effective mathematics teachers ensure students attain an accuracy rate of 80% during choral practice or written work before moving on. Other researchers support this, suggesting this approach results in higher success rates when students undertake independent practice (Anderson & Burns, 1987; Rosenshine, 2012).

Through questioning activities which include responses from all students, effective teachers identify students' errors, teach students self-checking

techniques, give hints to address these or re-teach as needed (Rosenshine, 2012). In contrast, less effective teachers merely give the right answer and move on.

Evidence in L&MIC is more substantial on effective literacy teaching than mathematics (Nag, et al., 2014; Piper, et al., 2018) with generally small-scale studies available. Nevertheless, the literature indicates similar features of effective practice in L&MIC as HIC (Pouezevara, et al., 2016): engaging students actively through questions and discussion, checking students' understanding, presenting arguments for challenge and defence, and facilitating student participation through teacher-student and student-student discussion. Evidence from a Nigerian randomised control trial of 120 schools highlighted that effective teachers interacted with individuals and groups, monitored learning and provided feedback. These teachers engaged students in all parts of the lesson, targeting reticent students while ensuring a gender balance in their interactions (RTI International, 2016).

2.4.5.4 Independent practice and summative assessment

The final stage of instruction, the application phase, focuses on providing students with opportunities for independent practice in seat or group work (Creemers & Kyriakides, 2011). Students need this to over-learn through rehearsal, gaining fluency and automaticity to enable them to tackle more advance, complex mathematics. These application episodes should be brief and interspersed with feedback (Creemers & Kyriakides, 2011).

When students work independently the teacher should circulate the room supervising seatwork, with some researchers suggesting engaging for less than 30 seconds (Rosenshine, 2009). Classes with lower test scores were those where the teacher had mediated more during seatwork, signalling students had not grasped the concept at a level required for independent study (Shayer, 2003).

Summative assessments act as a qualifier for further learning and provide opportunities to learn about learning (Braun, et al., 2006). Cognitive load theory advises spaced out frequent reviews in the form of homework, weekly and/or

monthly tests to transfer knowledge to students' long-term memory (Rosenshine, 2009; Hattie, 2008). These tests are most effective when students receive immediate feedback and undertake additional study on their areas of weakness, with re-assessment of proficiency. Testing has been associated with higher levels of achievement if teachers use this information to plan further teaching (Wiliam, 2011).

There is evidence that frequent testing results in significant advantage for less effective teachers but less so for more effective teachers suggesting a tipping point (Black & Wiliam, 1998). Teacher accountability can get performance to a certain point after which teacher autonomy drives up standards (Mourshed, et al., 2010; Glennerster, 2013). Some HIC researchers argue summative assessment is informed by instrumentalist education policies which direct a narrow focus on results (Hargreaves, 2005; Zyngier, 2016). Ignoring the cultural contexts in which teachers are operating, it can also limit teachers' autonomy in experimenting with new teaching approaches as the pressure to perform on the test dominates (Heitink, et al., 2016). However, a randomised control trial in over 800 Pakistani government and private schools of accountability measures publicising tests scores of children and schools found large learning gains (Andrabi, Das, & Khwaja, 2015). Nevertheless, the authors do not comment on the stresses on students or teachers of this managerialist, performative approach.

Remedial classes

Students experience the same teaching differently based on their prior knowledge, understanding and experience (Connor, et al., 2009). In any classroom there will be children with a wide variety of starting points which requires accommodation by the teacher (Glennerster, 2013; Evans & Popova, 2015). However, there is evidence that an overly-demanding curriculum in L&MIC is a contributory factor in the low learning-outcomes as teachers focus on the most able (Duflo, et al., 2011).

Remedial instruction programmes have been found to be effective in addressing this variability (Snilstveit, et al., 2016), with greater impact on lower scoring students, even when implemented by youth volunteers or informal teachers with

little training and only modest financial compensation (Damon, et al., 2016; Banerjee, et al., 2016). Remedial classes are a version of mastery learning, keeping learning-outcomes constant but varying the time students need to become proficient (Kulik, et al., 1990). In an Indian study the targeted students, removed from their regular classes due to low literacy and numeracy scores and given remedial lessons, made significant learning gains (Banerjee, et al., 2010; Banerjee, et al., 2007).

Next, I consider the final component of general pedagogical knowledge, that of teachers as professionals.

2.4.5.5 Teachers as professionals

A 'professional' implies someone who is setting an example for best practice (Tichenor & Tichenor, 2004). Sockett's (1993) definition of teachers' professionalism covers five aspects. In addition to *subject* and *pedagogical knowledge* discussed above, it incorporates *character* emphasising personal attributes such as patience, determination and respect for children. In a US based three-school study exploring teachers' own view of professionalism, researchers found greater consistency amongst educators in defining the character of a professional teacher than any other aspect. Teachers described an ideal professional as 'caring, nurturing, friendly, patient with all, well-organized, flexible, displaying confidence in the classroom; and remembering that he/she is a role model for students' (Tichenor & Tichenor, 2004, p. 92). Teachers felt professionals care about what they do and take pride in their work, adhering to moral and ethical behaviour.

The fourth characteristic Sockett emphasises is commitment to *continuous improvement*: keeping pace with current developments; constantly considering how practice makes a difference to students; reflecting on and self-evaluating teaching in order to develop as professionals; and adapting teaching in response to an analysis of students' needs and situation (Creemers & Kyriakides, 2011).

The final characteristic is *relationships beyond the classroom*: collaborating with colleagues; participating in a professional community; influencing policies;

educating the public about the values and practices of the profession; and working with parents. Insufficient parent-teacher engagement is cited as a contributory factor for the low learning-outcomes in L&MIC (Nag, et al., 2014).

2.4.5.6 Summary

Teachers from HIC and L&MIC have the same relative weaknesses and strengths as each other in relation to teaching practices but teachers in HIC have a higher level of classroom practice than their counterparts in L&MIC (Bold, et al., 2017). Classroom management and creating a positive environment for learning were strengths for both whereas instructional support for students was a weaker aspect, particularly in relation to questioning skills, facilitating discussion and using formative assessment.

Research suggests effective teachers undertake daily reviews of learning; spend longer presenting new material, in smaller steps, constantly checking understanding through skilful questioning and facilitating cognitive connections; seek a high proportion of correct answers before moving on; provide regular, supervised guided practice and undertake regular assessment, providing additional practice as needed. More generally experienced teachers understand classroom events and processes in a more connected, insightful way (Borko & Livingston, 1989). They monitor and interpret classroom events in greater detail and understanding, responding more fluidly and with less effort than less effective teachers (Watkins & Mortimore, 1999).

In the next section I explore Shulman's final knowledge base in relation to teachers of mathematics, which seeks to overcome the artificial distinction between content and general pedagogical knowledge (Depaepe, et al., 2013).

2.4.6 Pedagogical content knowledge

Pedagogical content knowledge (PCK) is the blending of content and general pedagogical knowledge 'that is uniquely the province of teachers' (Shulman, 1987, p. 8). It is practical knowledge that teachers need and apply during the act of teaching.

In mathematics, PCK involves an understanding of how different mathematical ideas are organised and connected; considering how ideas should be presented, carefully choosing instructional strategies, mathematical representations and mathematical tasks that make it easier for students to access content; an understanding of the misconceptions students can have and how to address these; and exploring alternative teaching approaches in order to cater to the full spectrum of students (Depaepe, et al., 2013). Drawing on a literature review from mainly HIC, these researchers question whether PCK can be separated from content or pedagogical knowledge.

Teachers' understanding of the mathematics they teach is related to how effectively students learn it: the difference between high and low scoring US teachers on PCK is associated with more than a month's additional learning for students per year (Hill, et al., 2005). This effect is of a similar order to the strength of the relationship between socioeconomic background and attainment. Several HIC studies have signalled that developing teachers' mathematical PCK shows greater positive correlation with students' learning-outcomes than content or pedagogical knowledge alone (Coe, et al., 2014; Timperley, et al., 2007; Blank & de las Alas, 2010). Teachers with insufficient PCK may set tasks and activities which occupy students but lack mathematical focus (Harvard Business School, 2018).

Mathematics teaching in L&MIC is dominated by use of choral responses and written practice in seat-work in relation to number knowledge with little focus on conceptual understanding (Nag, et al., 2014). Despite spending substantial time practicing mathematics facts, there is little impact on accuracy and fluency (Piper, et al., 2016). The authors argue that improved understanding of how to teach mathematics in L&MIC does not reach teachers who lack clarity on the skills students should be learning and how to teach these. It is, therefore, unsurprising that the literature describes teaching as rote, targeting only the lower skill levels of knowledge recall (Nag, et al., 2014). This rote practice may arise from teachers' perceptions that their role is to tell students how to do mathematics rather than support them to use and apply mathematics themselves (Amirali & Halai, 2010). This view was held by Pakistani teachers

who simultaneously considered mathematics as a creative, discoverable subject, having utility and the capacity to solve societal problems. The authors pose the unanswered question, why do teachers then not provide opportunities for students to experience mathematics in this way.

Effective teachers develop students' mental calculation, teaching a variety of methods and emphasising efficiency when selecting these (Askew, et al., 1997). These teachers use mathematical drawings and manipulative resources to aid students understanding of how mathematics works and interconnects. They develop visual representations that can be generalisable and link informal visuals explicitly to formal notations (Murata, 2015).

Effective mathematics teachers challenge all students to develop reasoning and problem-solving skills (Askew, et al., 1997). In contrast, less effective teachers emphasise the importance of students acquiring facts and standard methods and believe students vary in their ability to remember these. These teachers teach mathematics in discrete, instrumentalist ways, allowing students to work things out for themselves as opposed to supporting them to develop conceptual understanding which is what students need to master to solve mathematical problems.

Taught in a disconnected manner with an emphasis on learning facts using recitation and memorisation of standard algorithms, mathematics teaching in L&MIC pays little attention to problem solving (Reubens & Kline, 2009; Piper, et al., 2016). Therefore, students struggle with both procedural and more complex contextual tasks.

Researching a highly effective US school serving children from disadvantaged backgrounds, Boaler (2006) identified groupwork as a key component of 'multi-dimensional' mathematics classes. In these classes, teachers valued many aspects of mathematical work rather than the single emphasis on correct procedural execution. Multi-dimensionality connects different areas of mathematics and promotes different representations of the same ideas (Harvard Business School, 2018). It values students 'asking good questions, helping others, using different representation, rephrasing problems, explaining

ideas, being logical, justifying methods, or bringing a different perspective to a problem' (Boaler, 2006, p. 365).

2.4.7 Summary

The literature suggests that effective features of generic teaching in L&MIC show little difference than those found in HIC (Coleman & Earley, 2005). Remarkable similarities in the process factors of educational effectiveness exist: school leadership and culture, relationship with parents, and effective teaching and learning. Notable differences included nepotism, rates of punishment, and convincing teachers they make a difference in L&MIC (Coleman & Earley, 2005).

To structure cognitively demanding learning activities, teacher need to have a broad pedagogic repertoire to draw from (Muijs, 2010; Stronge, et al., 2007; Corringer & Valli, 2009). Effective teaching practices in L&MIC comprises teachers' questioning style; their effectiveness in demonstrating and explaining; planning and varying lesson sequences; flexible use of whole-class, group and pair work and use of resources beyond the textbook (Westbrook, et al., 2013).

Effective pedagogy has communication at its centre. It is the teacher's skill in listening, observing and responding, her skill in knowing which teaching tool to select from her toolbox which helps children's learning to progress (Wassermann, 2015). However, an Indian LCPS study highlights 'highly ritualised and rigid' lessons and strongly reiterative nature of teaching in these schools, covering past ground rather than supporting progression in learning, emphasising propositional rather than procedural knowledge (Smith, et al., 2005, p. 615).

2.5 Conclusion

Alexander (2008) argues that effective pedagogies depend on behaviour (what teachers do), knowledge and understanding (what teachers know) and beliefs (why teachers act as they do). Using Shulman's (1987) framing of teachers' seven knowledge bases (educational goals, purposes and values; educational contexts; students; curriculum, content; general pedagogy; and pedagogical content) I explored each in relation to mathematics teaching in L&MIC in

general and in LCPS-schools in particular. Exploring general pedagogical knowledge in detail, I used instrumentalist literature to coalesce on five key components of effective teaching: planning and preparation considering students starting point; a conducive classroom environment; effective instructional practices; opportunity for independent practice and summative assessment; and teachers' role as professionals.

Instrumentalist pedagogy is enhanced by the enactment of transformative, reciprocative pedagogies challenging teachers to be explicitly alert to inequities that exist and deliberately counter them (Zyngier, 2016). Responding to and critically commenting on students' lived experience is transformative and emancipatory. These pedagogies connect with students' cultural knowledge and identities, and facilitates their ownership of learning by connecting with issues of equity, inclusion, expectations and aspirations, focusing on the role communication plays in this. But this deeper level of skill requires teachers to be systematically supported to develop their practice. It is only then that pedagogy will empower the most marginalised students with the belief that schooling can make a difference and help them to live their own authentic and authoritative lives (Affouneh & Hargreaves, 2015).

I conclude by presenting a theoretical framework which informs my research design.

2.5.1 Implications for research design

Figure 2.1 sets out the theoretical framework arising from the literature in response to the research sub-questions, RQ1 to RQ4. It is based on Alexander's (2000) conception of teaching discussed in Section 2.3.1: organisation (which I study empirically), purpose and structure. Although these are interlinked, I theorise the *purpose* aspect by drawing on the concept of pedagogy discussed in Section 2.3.2 and Shulman's (1987) articulation of teachers' knowledge base regarding educational goals, purpose and values; contexts; and students discussed in Section 2.4 to explore why teachers do what they do. Communication is placed here as its informed by teachers' beliefs and ideas about teaching and learning but clearly communication also features in teachers' instructional practices. Aspects of their role as professionals will

also be informed by teachers' views of the professional self and the values they hold regarding it.

All seven of Shulman's knowledge base inform the *structure and form* of teaching discussed in the instrumentalist pedagogy literature in Section 2.4. giving rise to five main components, RQ3.1 to RQ3.5, each with its own set of themes (1a to 5c).

At the planning stage as teachers decide what to teach and how, they will be informed by knowledge of students, curriculum, content and pedagogy (general and PCK). To theorise instructional practices, I draw on predominantly the last two knowledge bases. However, this aspect is clearly informed by all seven knowledge bases.

In the next chapter, I describe the methodology which builds on this theoretical framework to answer my research question.

Figure 2.1Theoretical framework for teaching and learning

<table>
<tr><td></td><td colspan="3">What is mathematics teaching and learning like in Karachi's low-cost private sector (LCPS) primary schools?</td></tr>
<tr><td rowspan="2">RQ4: Institutional environment</td><td>Space, time & patterns of student organisation</td><td>RQ2: Purpose, ideas, values & beliefs by which teaching is informed, sustained & justified</td><td>Teaching has structure and form (RQ3)</td></tr>
<tr><td>To be studied empirically:
- School infrastructure
- School day
- Class sizes</td><td>RQ1: Knowledge of students:
Perception of students and parents

RQ2: Knowledge of educational goals, purposes and values, and contexts:
- Expectations of students
- Inclusion and equity
- View of teaching and of mathematics

RQ3.3a. Communication:
initiation/response/feedback
Mathematical communication

Exhibiting professionalism</td><td>RQ3.1. Approach to lesson planning and preparation
Knowledge of:
a. Content
b. Curriculum
c. Pedagogy (general & content)
d. Students
e. Adapting teaching
f. Planning use of resources (RQ3.3g)
g. Planning and making use of formative (RQ3.3d) & summative assessment (RQ3.4b)
RQ3.2. Creating a positive classroom environment
a. Ethic of care
b. Developing affective relationships
c. Behaviour for learning
d. Rules, routines and rituals
RQ3.3. Establishing effective instructional practices
General Pedagogical knowledge
b. Lesson framing (orientation)
c. Direct instruction, scaffolding learning & guided practice
d. Formative assessment
e. Questioning
Pedagogical content knowledge
f. Developing conceptual understanding
g. Use of resources
h. Making connections
i. Dealing with errors
RQ3.4. Providing independent practice and using summative assessment
a. Homework
b. Summative assessment system
c. Remedial classes
RQ3.5. Acting as professionals
a. Professional character
b. Commitment to continuous improvement
c. Relationships beyond the classroom (colleagues, parents, influencing policies)</td></tr>
</table>

Chapter 3 Methodology

In this chapter I present my data collection and analysis approach. I also reflect on my role as a researcher and pertinent ethical issues.

3.1 Introduction

Chapter 2 considered key components of effective teaching and its relevance to improving learning, from HIC and L&MIC, which gave rise to my theoretical framework (Page 64). In this chapter I explain how I answered my main research question: What is teaching and learning mathematics like in Karachi's LCPS primary schools? To do this, I explore the following related sub-questions, addressed through a mixed-methods case-study research methodology:

1. *Who are the students attending LCPS-schools?*

   Explored through quantitative analysis from independent impact evaluation data of children registered to attend Karachi's LCPS-schools (secondary data) and observational and interview evidence from the field visits (primary data)

2. *What values underpin teachers' instructional and professional practices?*

   Explored through interviews with teachers in the field visits (primary data)

3. *What instructional practices do teachers use to teach mathematics?*

   Explored through lesson observations and teacher interviews in the field visits (primary data)

4. *How does the institutional environment support (or hinder) the development of mathematics teaching practice?*

   Explored through observations, document reviews and teacher interviews in the field visits (primary data)

Too often the literature presents sweeping criticism of L&MIC teachers' practice (Bold, et al., 2017). However, it is light on detail in general, and in Pakistan in particular (Thomas, Salim, Munoz-Chereau, & Peng, 2012). To inform policymakers in their endeavour to improve learning-outcomes we ought to

study how teachers with expert practice, located in these settings, bring about learning (Wilson, 2013). Therefore, I focused my research on schools which were more likely to have good practice as I am influenced by process-production tradition of school effectiveness research which seeks to understand how and why some teachers add more value to their students and whether these are sustainable in different contexts and over time (Sammons, 2012).

While there are many evaluations, including randomised control trials, there are very few school effectiveness research studies in L&MIC. This means that an articulation of effective features of teaching L&MIC students is missing, a gap this study addresses. An illumination of effective practice helps to generate information on what works and expands the effectiveness literature base beyond HIC. The findings also shift the narrative to a more hopeful one. This research, while not attempting to be generalisable, contributes to school improvement efforts in L&MIC by providing evidence rooted in national contexts, as opposed to externally informed and imposed. It illuminates Karachi's LCPS teachers' practice.

3.1.1 Context

Karachi with a population of 23 million is the seventh largest city in the world (World Population Review, 2016). My quantitative research data is from 20 of its poorest localities with the highest likelihood of having out-of-school children (Haq, 2014; UNESCO, 2015). My pilot and case-study schools were located in these localities and some, including school-B, were described by locals as being in 'red-zones' no-go areas for them. Security in Karachi is an issue and it is well-known for crimes such as robbery as well as political and ethnic violence.

3.2 Research methodology overview: mixed-method, case-study research

In this section I set out my rationale for a mixed-method case-study methodology to answer my research questions.

A case-study is an 'empirical enquiry that investigates a contemporary phenomena in depth and within its real-life context…relies on multiple sources of evidence … converging in triangulating fashion' (Yin, 2009, p. 18). I wanted

to ‘identify and describe before trying to analyse and theorize’ in order to provide a rich description using different methods and data sources (Stark & Torrance, 2005, p. 33). I adopted an exploratory mixed-methods case-study approach as my research seeks to describe LCPS teachers’ practice and the values that underpin it.

The nature of the social interaction between teacher and student I studied had pedagogy as the policy focus with the site as LCPS-schools which enrolled children poor enough to be eligible for DFID funding to attend school. I set my boundary of study at what teachers do and what they say about what they do (Stark & Torrance, 2005). I interviewed senior leaders, as they have a role in setting the institutional environment and pedagogical culture within the school. Due to a combination of limited time and resources, I did not extend to parents or students.

My research questions are focused on teachers of students who are poor. I, therefore, wanted to understand who the students are and describe the teaching they experience, including the values that underpin their teachers’ practices. My research methodology utilised first-hand qualitative data on teachers’ mathematics practice in five LCPS pilot-schools and two in-depth case-study schools and quantitative analysis of secondary data on students’ characteristics. The pilot helped to test out my methodology, enriched the description of practice and enabled greater generality than just two schools would have. By triangulating different sources, I arrive at deeper, more corroborative descriptions thereby adding to the evidence base on LCPS-schools (Cohen, et al., 2011).

My approach uses a ‘pragmatic paradigm’ that rejects methodological conflicts between quantitative and qualitative sources of data and the binary standpoints of positivists and interpretive positions, reflecting real life (Muijs, 2012, p. 59). This combination ‘generates a synergy that neither can alone… adding extra value’ (Sammons, 2012, p. 18). Pragmatism seeks the most practical way to answering the research questions adopting a ‘methodologically eclectic, pluralist approach’ (Cohen, et al., 2011, p. 23).

I undertook an instrumental case-study which seeks to capture information about a theme, which in my case is teaching and learning mathematics (Hamilton & Corbett-Whittier, 2013). I replicated my methodology in each of the five pilot-schools and two in-depth case-study schools enabling me to arrive at a richer, more comprehensive understanding of teachers' practice (Cohen, et al., 2011; Hamilton & Corbett-Whittier, 2013). These multiple sources of data results in higher quality rating (Yin, 2009) and strengthened subsequent inferences (Cohen, et al., 2011).

This approach is informed by the 'applied research and evaluation tradition' of case-study methodology, which moves away from the long-term intense focus on a single case-study to a short-term focus across multiple cases (Somekh, 2005, p. 34). The intention of this approach, used in educational research, is to improve decision-making and practice as the evidence across cases is considered more robust (Yin, 2009). Combining lesson observations with interviews contributes to the limited application of mixed-method case-study methodology in L&MIC (Muijs, 2012).

3.2.1 Overview of data collection approach

Next, I provide an overview of my research design, which uses quantitative and qualitative data, my data sources and the research timeline.

First, to shed light on the students attending LCPS-schools I analysed secondary quantitative data produced by Oxford Policy Management (OPM), an independent organisation commissioned by DFID to evaluate the population attending my case-study schools. Second, to explore teachers' practice and what informs it, I undertook two field visits to Karachi's LCPS-schools. In the first, a pilot study, I spent a day in each of five LCPS-schools. In the second, I spent a week each in two schools, school-A and school-B (also a pilot-school), to conduct a more in-depth, exploratory, mixed-methods case-study.

The data collection methods in both the pilot and in-depth schools were similar and so in this section I deal with both stages together. In all schools, barring one pilot-school, I observed mathematics lessons, interviewed teachers and senior leaders, reviewed planning documentation, looked at students'

mathematics books and talked to them about their work. Figure 3.1 sets out the research process and Figure 3.2. sets out the research timeline.

Figure 3.1 Sequence of my research activity and data sources

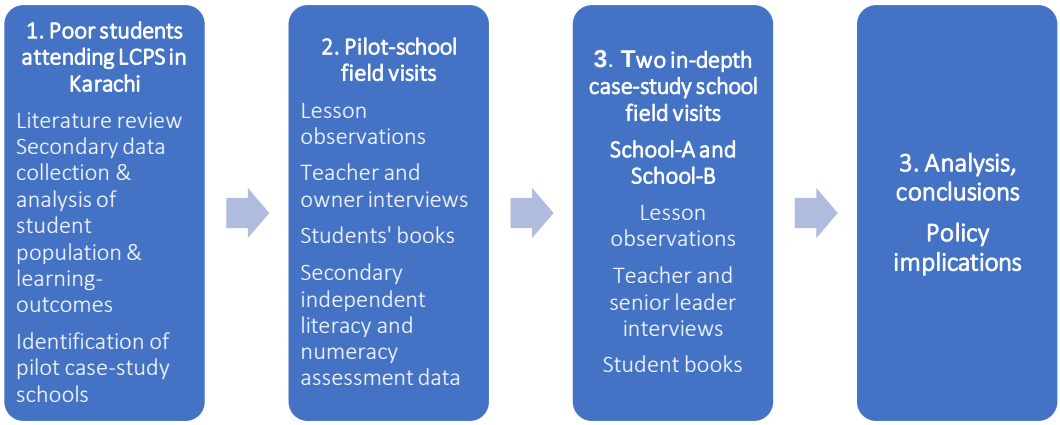


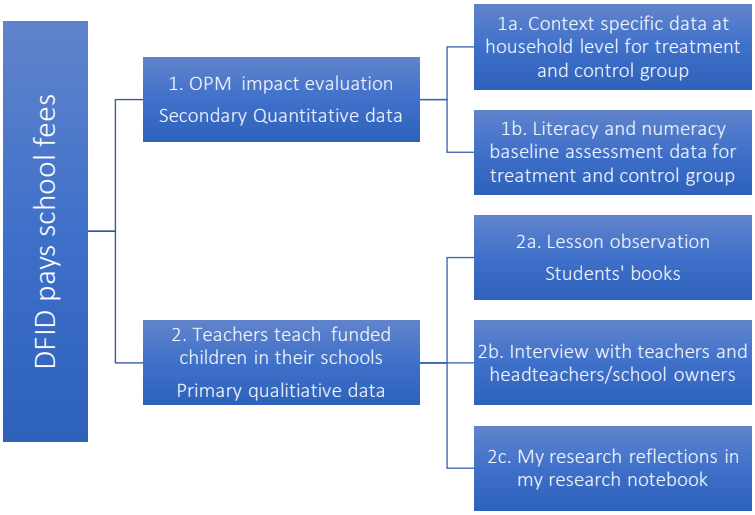
Figure 3.2 Research timeline

Evidence sources	Timeline
1. Formal thesis proposal approval	March 2015
2. Primary field visit data from five pilot-schools; interviewed three teachers; five senior leaders; four mathematics lesson observations; and a visit to three classes where tests were being conducted in one school	February 2015
3. OPM secondary data on households and literacy and numeracy assessment	June 2015
4. Field visits for in-depth case-study in two schools: School-A and School-B	December 2018
13 Interviews in school-A and nine in school-B; some recorded on an iPhone and later transcribed; others recorded in notebook alone 14 mathematics lesson observations in school-A 16 mathematics lesson observations in school-B	
5. Thesis write-up	Dec 2018 – July 2019

Figure 3.3 sets out how the different sources of evidence, which I expand on next, synthesise to provide the data for my findings. I adopted a component design to the mixed-methods approach studying each school on its own and the student population data separately and then bringing it together at the analysis stage (Greene, et al., 2005).

I begin by describing the quantitative then the qualitative data.

Figure 3.3 Key data points for my research



3.3 Quantitative data about the student population

I anticipated that the students' characteristics could have a bearing on teachers' expectation of the previously out-of-school, poor student population and, therefore, the pedagogic approaches they employed. Consequently, I sought to study the school population in more detail. I acquired quantitative data from OPM which was substantially delayed: no further data following the baseline data was released.

Using a central database of all children registered by their families to receive DFID funding to attend Karachi's LCPS-schools, OPM set up a randomised sample of a treatment group comprising out-of-school girls and boys, aged five to nine, funded to attend LCPS-schools and a control group who were not. Of the schools that were to receive DFID-funded children, five were my pilot-schools where I observed the treatment group children being taught. From household questionnaires and learning assessments in literacy and numeracy at baseline, OPM (2015a) had a wealth of data about these children. Figure 3.4 sets out the sample population in more detail.

Figure 3.4 OPM sample population numbers in Karachi

Household interviews		Children interviews		Learning assessment data	
Treatment	Control	Treatment	Control	Treatment	Control
1,233	1,228	2,372	2,410	2,141	2,188

I used OPM's data to analyse not only the characteristics of my sample population but also the factors that correlated with their learning-outcomes in mathematics. While OPM's (2015b) and my headline findings were similar, my analysis of the data is in greater depth, particularly in relation to learning-outcomes. For example, OPM summarise findings from their mathematics assessment data in two pages whereas I consider this in relation to several contextual factors and built a regression model.

The second source of quantitative data I used was DFID's baseline and six-month literacy and numeracy assessment data of the children in each of my pilot-schools. This was not a census approach; random children were selected to sit these assessments. This data allowed me to triangulate the findings from my five pilot-school observations with learning-outcomes for the classes I observed and select the school with the highest learning-outcomes, school-B, for the in-depth case-study.

3.4 Qualitative data from pilot and case-study schools

In order to answer my research question regarding teaching and learning in mathematics, I observed mathematics lessons, interviewed teachers and the school's senior leaders, and looked at students' books. Next, I provide detail about this qualitative data collection, including the school selection process, how I conducted the observations and the interviews. I used similar data collection approaches in the pilot and in-depth schools and, therefore, here I describe only when my practice differed.

3.4.1 Selection of, and access to, the pilot case-study schools

I undertook two field visits over three weeks, a pilot and in-depth case-study visit. In the pilot phase I visited five primary schools within a one-week period in

February 2015 (See Appendix 1 for the characteristics of each school). For ease of access, both physically and to ensure EFS (a DFID funded organisation administering the programme) was open to my visit, I asked them to select the schools. I had requested schools where classes had been running the longest: EFS (2015) reported 22 schools had been established in 2012 and said they chose the five schools that were the easiest for me to physically get to. EFS could have selected the best schools for me to visit thereby introducing a sample bias but as I was seeking to study good practice this would not have compromised my findings. In actuality there was substantial variation between the schools in terms of locality, physical infrastructure, pedagogical practice and learning-outcomes.

Next, I selected two in-depth case-study schools. As I wanted to see good practice, I chose schools that had a reputation for delivering good quality education for the poor. School-A is part of a large national chain of schools, globally recognised for its delivery of quality education for the poor. School-B was identified from the pilot study because it had far higher learning-outcomes than the other four pilot-schools, and interviews with the headteacher highlighted a greater depth of knowledge about teaching and learning than I found in other schools. Although only 10 minutes apart by car, and serving similar communities, school-B appeared to serve a much more deprived population than school-A. They also had very different support structures: school-A was subject to their headquarters' stringent accountability framework as well as support, whereas school-B was a standalone school with no external support.

In all schools I had the freedom to observe any classes. In the pilot phase I observed all the teachers teaching mathematics who had DFID-funded children in their classes and then interviewed them. This was invariably classes 1 or 2 because the programme had only been running for two years in 2015. In the in-depth schools in 2018 I observed classes throughout the primary school.

3.4.2 Observations

I set out three kinds of observations I conducted in order to understand the context the teachers were operating in and their pedagogical practice. Firstly,

an observation of the school context involving the physical environment and the students. This was important to contextualise the characteristics of the students and helped to answer my first research sub-question. Secondly, I conducted direct observations of teaching in mathematics lessons to answer my third sub-question. These also gave me evidence for my second and fourth sub-questions which enriched the interviews. Third, I looked at students' books to identify the type of mathematics they did and the kind of feedback teachers gave them. I expand on each next.

3.4.2.1 Observations of the context and environment

I undertook observation of the environment the students learned in to give me an overview of the physical, human, interactional and programmatic setting (Cohen, et al., 2011). To help me understand the context of each school and provide ecological validity, I conducted observations of the surroundings, inside and outside the school, noting implications about the location and status of the people involved and the poverty levels (Cohen, et al., 2011). For example, I focused on the nature of the surroundings of the school, the décor, the children's and teachers' attire. I considered the culture and expectations evident from the manner in which teachers interacted with students and with each other.

I took photographs of the surroundings and the school building but used them judiciously to avoid risk of identifying schools. These added new 'dimensions of understanding' of what I was studying and conveyed 'important case characteristics' (Yin, 2009, p. 111). This type of observation is an important aspect of good quality case-study providing richness of evidence. I used the pilot visits to create an observational focus, Figure 3.5, for the in-depth case-study schools and used Alexander's (2000) work to record classroom layout.

Figure 3.5 Environmental observation focus

Observation focus	Components
School layout	Playground Classrooms Safety related issues (exposed wires; barriers) Standard of cleanliness Teachers' space (staffroom; headteachers' office)
Class layout	Windows Doors Natural light Fans Blackboard Layout of desks and chairs Room to move Displays of students' work

3.4.2.2 Observation of teaching

In order to explore teachers' practice, lesson observation is a vital, central focus of my methodology (Jones & Somekh, 2005; Hopkins & Ahtaridou, 2014). It allows the study of the educational process in its naturalistic setting, providing detailed and precise evidence, leading to increased understanding of the teaching process. Another important rationale for observations was the limited exemplification of teaching practice, such as interactive dialogue, in L&MIC classrooms (Black, 2015).

The challenge of observing is making sense of what you see and what to record. Given my professional background has been substantially about observing teachers and children, I was confident with the concept of observing lessons but not about doing this with the rigour demanded of an academic study. Moreover, as a researcher there is a change in focus from evaluating to observing, describing and theorising. However, both my professional experience and the literature review provided a framework in relation to instructional practices to focus on. I made decisions in advance about the broad range of things and 'occurrences of certain types of behaviour' I wanted to observe (Yin, 2009, p. 109).

During the pilot interviews, teachers and senior leaders demonstrated a strong moral purpose and drive to teach the poorest. They noted the work they had to do to get previously out-of-school children socialised into the school environment. The pilot observations suggested that they had been successful in this with rituals and rules adhered to by students. In the in-depth study I wanted to test this out further, particularly how the 'pedagogy of poverty' which results in lower expectations of poorer student played out or whether these schools undertook reciprocal pedagogies (Zyngier, 2016).

I wanted to explore instructional practices such as scaffolding and modelling, the quality of communication between teachers and students, teachers' questioning and how they handled students' questions. The theoretical framework (Figure 2.1 on page 64) set my observational focus in the in-depth schools: I was looking for certain things, as set out in the observation schedule (Figure 3.6), rather than at things and adopted a semi-structured, 'focused' observational approach to do so (Hopkins & Ahtaridou, 2014, p. 89). I refined the observation schedule following my pilot visit simplifying it to the components of instructional practices articulated in Section 2.4.

I was interested in the kinds of communication teachers employ, what they do, what resources they use, how children interact with these resources, therefore, a tick list or timed observation schedule would not have sufficed. I wanted to present a vivid picture of what it is like to be in the in-depth schools and to be in the mathematics lessons and so sought materials for rich descriptions. I aimed to describe, through capturing in detailed note form, what was taking place rather than to ascribe meaning to it and capture the richness of the teacher dialogue rather than a timestamp of what happened. However, every 10 minutes I would scan the classroom and note down what teachers and children were doing, seeking to identify if they were engaging with what the teacher was saying and if not, then how many were not, and what else they were doing. This arose from pilot findings as to how long teachers gave direct instruction for before conducting other activities.

Figure 3.6 Observation schedule of classroom practice informed by the theoretical framework

RQ3.2 Classroom environment	Teacher (T) developing affective relationship	Student (S)
3a. Ethic of care 3b. Developing affective relationships 3c. Behaviour for learning 3d. Rules, routines and rituals	T management of behaviour; tone of voice; facial expression Need for instruction, reprimand, praise Use of engaging resources	S responsiveness S participation, signalling engagement S handling of resources
RQ3.3 Instructional practices		
3a. Communication/developing mathematical literacy	T emphasis on vocabulary, mathematical presentation, accuracy T-to-S, S-to-T and S-to-S dialogue Time T talks	S use of mathematical language S written work: quality of mathematical presentation
3b. Lesson framing	T orientation of lesson Review of past lesson and homework	
3c. Direct instruction, scaffolding & guided practice 3f. Developing conceptual understanding **3g.** Use of resources	T explanation, making connection between topics and methods T structuring of task, use of resources T action during guided practice Cognitive demand of work set	S engagement with explanation & tasks
3d. Formative assessment **3e. Questioning**	T checking of S understanding T identification and handling of S T quality of questioning: open/closed/cognitive demand	Quality of S response to T questioning S ability to deal with errors S asking questions
4. Independent practice & summative assessment		
	T time on seatwork T action during seatwork, including marking Quality of T written feedback to students	S engagement during seat-work S engagement with homework S responsiveness to feedback

I had a clear observation focus and adopted a naturalistic observation approach (Cohen, et al., 2011) observing participants in their settings. I observed the lesson, writing down what the teacher did and said, and key points of conversations, particularly where they related to components RQ3.1 to RQ3.5 in my theoretical framework. I recorded my lesson observations in note-taking form against the descriptors set out in Figure 3.6 (Somekh, 2005). Note-taking to some extent addresses the two problems associated with operationalising pedagogy: being too specific and not being specific enough (Coe, et al., 2014). It enables the collection of rich and detailed data but requires high levels of alertness which my professional experience of classroom observations had prepared me for. However, while notetaking is the easiest form to record it is the most difficult to analyse (Basit, 2010).

As part of my observations, where appropriate and I had permission, I took photographs of teachers' blackboard work and children's work in their books. I framed the photographs so that neither teachers nor students were identifiable and offered teachers the opportunity to check this. As I did not have permission to video lessons I was only able to record observations by hand in my notebook, during and after the lesson. Therefore, the depth of my analysis was limited to what I could capture in the time I had. There were some fantastic exchanges which lost detail in my attempt to write them in my notebook. Nevertheless, adhering to these rules gave me access and it was a privilege to be allowed in.

Classrooms are rich, diverse interactive environments. It is impossible to stay detached and even detachment itself affects the class dynamics. Consequently, participation is rarely objective and under constant construction (Midgeley, et al., 2013). While my predominant observation stance was non-participatory (Wragg, 1999), I was at points an observer-as-participant which fits in well with a pragmatic approach (Cohen, et al., 2011). I set mathematics questions to students when they were working on their own and the teacher was not talking to them. I wanted to see if children had understood the concept the teacher was explaining or if they could do more cognitively demanding work than had been set so I would set them more difficult questions to tackle on the topic. I was not just observing, as through my questioning I was becoming a co-constructer of

evidence, creating new knowledge for my research about what was happening in the class.

Number of observations

In the pilot I observed four teachers for 25 to 30 minutes in four schools. In the fifth school, students were doing tests so I spent 10 minutes in three classrooms 'observing' the tests and talking to students about them.

I arrived at both in-depth schools before assembly and stayed until school ended, around 0800 to 1305 in school-A and 0800 to 1230 in school-B. In school-A in Kindergarten (KG), class 1 and 2, the class teacher taught the mathematics lesson whereas the remaining classes were taught by two senior teachers, Amna-A and Huda-A, who were mathematics specialists. This meant I observed these two teachers more often. Figure 3.7 provides details of the lessons observations. I gave teachers pseudonyms to anonymise them: names prefixed by A- or B- are school-A or school-B teachers respectively.

Figure 3.7 Number of lessons observed and teachers interviewed

School	No. of observations	Teachers observed	No. of interviews Semi-structured unless otherwise stated
Pilot-schools 1 to 5 5 days	3 part-lessons 4 full lessons	Hala-PS1 Rani-PS2 Qudisia-PS3 Maryam-PS5	8 (5 senior leaders; 3 teachers)
School-A KG1 to class 5 5 days	2 assemblies 2 part-lessons 14 full 40 minutes mathematics lessons, including a demo-lesson for class 1 teacher taught by the headteacher and Amna-A	Amna-A (senior teacher) Huda-A (senior teacher) Shazia-A Nighat-A Aliya-A Aisha-A Yasmin-A	11 (3 with the head teacher and 2 FGD)
School-B Nursery, KG1&2 to class 4 and class 5,8 and 10 4 days	2 assemblies 5 part-lessons 16 full 40 minutes mathematics lessons, including three lessons in the secondary school	Zaina-B (senior teacher) Asma-B (senior teacher) Tasleem-B Hajra-B Noor-B Zara-B Sara-B Amber-B Sadia-B Saima-B Sumera-B	9 (1 with the headteacher)
Total	10 part-lessons 34 full-lessons	22 teachers observed	28 interviews

Observation issues

A key criticism of observations is that they may not be representative. Teachers may be having a bad day or observation was not of typical practice of the school let alone of the teacher. In order to ensure I was getting to what practice was typically like I observed several different teachers across the two schools, totalling 34 full lesson observations. This enabled me to triangulate different

sources of data, as different teachers can execute the same pedagogies in different ways (Gabrielatos, 2014). Therefore, these observations gave me useful insight about teachers' pedagogical practice and as I focused just on mathematics, the range of practice was narrowed.

A further criticism of lesson observations is that the teacher is 'performing' for the benefit of the observer, delivering showcase lessons rather than normal ones (Kazmi, 2007). However, the teachers were not aware of my pedagogical focus and even if they were showcasing this still provided valuable, legitimate evidence about what they were trying to showcase.

3.4.2.3 Observing students' books

While observing lessons I looked at students' exercise books and textbooks, where available. This amounted to about five to six books per lesson and provided contextual information to enrich my lesson observations. This was not an in-depth study but did give me an indication of how they presented their mathematics and the kinds of mathematics they did. It also provided me information on the kind of written feedback teachers gave. This set a context for understanding teachers' feedback as experienced by students (Hopkins & Ahtaridou, 2014). I photographed examples of students' work and teachers' feedback.

3.4.2.4 Field notes

I made use of field notes, voice recording my reflections on my phone or in my notebook to add depth to the evidence base. This would often be reflections about how I felt and were subjective but useful aide-memoires after a passage of time.

3.4.3 Interviews with teachers and senior leaders

In this section I outline the types of interviews I conducted and the rationale for them. My original plan was to conduct semi-structured interviews, which make up the majority of my interviews. However, as other teachers wanted to talk to me, I also conducted focused group discussion (FGD) and used opportunities for informal discussions. Figure 3.7 provides details. Alexander's (2008)

definition of pedagogy demands an understanding of why teachers do what they do, which I ascertained through interviews. Therefore, in both the pilot study and in-depth case-studies, my aim through interviews was to understand teachers' craft and cultural knowledge (Wilson, 2013).

The interviews were a crucial source of case-study information in order to connect what the teachers did with why they did it. I sought to have an 'inquiring mind during the data collection' willing to go wherever the evidence took me and was prepared to be flexible with the questioning and the time given to the interviews (Yin, 2009, p. 69). I planned key questions in advance based on the theoretical framework arising from the research sub-questions but wanted the flexibility to explore and expand on the responses given. Appendix 2 sets out the main questions and talking points I used in my interviews. I also wanted to follow new lines of enquiries offered up from the interview itself and so having the interview semi-structured helped (Cohen, et al., 2011).

Next, I explain why and how I conducted semi-structured interviews, setting out the areas of focus, in order to answer research sub-questions RQ2 and RQ4. I also reflect on the interview dynamics I was conscious of and how I sought to mitigate these. Appendix 3 sets out examples of my interview transcripts.

3.4.3.1 Semi-structured interviews

I conducted semi-structured interviews as guided conversations with participants (Yin, 2009). This allowed me to explore their version of what had taken place in the lesson and follow up interesting aspects in response to my questions. I found that the discussion with the teachers based on what I observed immediately preceding the discussion helped us to be closer in arriving at a common meaning. It also allowed me to link teachers' practice to what they said about their practice. I was able to say things like 'tell me why you did that…' which helped to make sure my construction of meaning from the observations did not differ hugely from the participants (Jones & Somekh, 2005, p. 141).

It was easier in school-A to discuss the lessons with the teachers immediately. However, teachers in school-B had a greater number of classes and break

duties making it more difficult to hold discussions with them immediately. They also left school at 1230 to undertake their tuition roles. In school-A on the first day teachers were hesitant to talk to me, and the headteacher would join the interviews. She also insisted teachers had their break rather than meet me. By the second day greater trust had been established and teachers were more relaxed and open to meeting me on their own, becoming keen to talk to me. I also used opportunities between lessons to talk to teachers.

Given the sensitivities of recording data, including personal information, I did not systematically collect age, qualification and experience information across the schools. During interviews I would ask for information and if they gave it I recorded it. Therefore, the information is based on those I interviewed and were willing to give information as opposed to representative of the whole school.

In the interviews I thanked teachers and explained how I would be using the data, my role as a researcher and my professional roles. The younger teachers in particular would ask me for feedback on their lessons and how they could improve. I explained my role was not to do that. However, at the end of the visit I felt it professionally courteous to offer a discussion about what I had observed. This resulted in deep pedagogical discussion. It also helped to give teachers a preliminary view of what my research was likely to focus on and promoted a more collaborative mode of research participation (Midgeley, et al., 2013).

3.4.3.2 Focussed group discussions

While I had not initially planned to do FGDs, in school-A teachers began to join my semi-structured interviews. They wanted to participate and share their views bringing to life the definition of a FGD as ‘a social process through which participants co-produce an account of themselves and their ideas’ (Barbour & Schostak, 2005, p. 43). During FGDs I was conscious of representation and gatekeeper related issues but as all teachers were present in the staffroom after school, there was full representation and the FGD took on a life of its own. I held two FGDs and used these to gather evidence on the themes emerging from observations and semi-structured interviews: ethic of care, who the students were, teachers’ view of planning and what made a good teacher.

The FGDs also became opportunities to observe group dynamics, such as camaraderie and hierarchy of the staff. For example, the senior teachers who were younger would invite the older teachers to answer questions first.

School-B did not have a staffroom or time for teachers to convene, just two tiny offices for the senior teachers which also served as the students' water room, so I did not conduct FGDs here.

3.4.3.3 Informal discussions

Sometimes opportunities would emerge to discuss a particular theme with individuals that were unplanned. For example, in school-A the cleaners were available for a discussion which I took up after observing a cleaner's child in the lesson. Or a teacher would want to talk to me even if I had not observed them, such as a science teacher. Or parents would come and speak to the headteacher which I wanted to explore further. In these cases, I adhered to the principles of semi-structured interviews.

3.4.4 Voice recording

Both schools were in conservative areas and had female only faculties by design. (There was one part-time male teacher in school-B to teach advance mathematics in the school's garage). The vast majority of teachers covered their faces when they left the school building. They did not wish for their images, and sometimes their voices to be recorded. Therefore, before each interview or lesson observation, I sought permission to voice record on my phone, some teachers allowed this, others did not. Where I had permission, I recorded the interviews and snippets of lesson observations (which were not very clear) and then transcribed them on my computer. In school-B when the headteacher or teachers had not allowed me to record, I translated responses from Urdu into English and handwrote them in my notebook. The teachers explained they were worried about social media and where my recordings may end up.

The recordings and the notebook helped to jog memory when time had passed between field visits and write up (Hopkins & Ahtaridou, 2014). All interviews took place in Urdu and as I speak it I did not need a translator. Sometimes key words do not translate easily from Urdu to English as they may have more

spiritual or contextualised meanings. Where this was the case I provided wider description of what they mean in my transcripts.

3.5 Key concepts in interacting with school staff

While I was conducting the interviews and observations I was mindful of the key concepts of: power and social position; value and trust; and meaning, interpretation and uncertainty (Wragg, 2002; Barbour & Schostak, 2005).

Power and social position

Given the power relations, my social position and the limited amount of time, I had to build trust quickly, establishing the rules of engagement and confidentiality, and share the purpose of my research. Although I, like my interviewees, am an Asian female, my visit to the pilot-schools had been facilitated by EFS who funded these schools. (For the in-depth case-study schools I had gained access myself after the DFID programme ended and so the power dynamics were less overt). The pilot-schools clearly thought an important visitor was coming and, therefore, they were careful in what they said. However, in the case-study schools they were more open.

At that time I was a senior government official in the UK education sector, fluent in English, undertaking a doctorate, confident in my professional practice and personal well-being, as well as in moving through the various social strata of Pakistani society. This background was in sharp contrast to my interviewees who as teachers were in a low-status occupation in Pakistan, who worked in the LCPS with little job security and by definition low pay in the poorest areas of Karachi. Although I have experienced poverty and could be empathetic they did not know this and would not have known this as I recorded the interview on my iPhone in hesitant Urdu but fluent English. Being conscious of subtle signs of power I stayed in the classrooms they taught in, politely rejecting fans or the food and drink provided to me by the owners and not to the teachers (Barbour & Schostak, 2005).

3.5.1.1 Value and trust

At no point during my interview was there any indication that the teachers held a value on the information they were providing me. I got the impression teachers were surprised at my focus and at even having their views heard. Once trust was established and teachers realised I was not an arrogant ‘memsahib’, they became more confident and open in articulating future improvements they thought should be made. Nevertheless, in the pilot there was a reluctance or a pedalling back from anything the teachers felt may be viewed as criticism. Several of the teachers were cautious about what they said, wanting to reassert they were not criticising when I asked how things could be improved. Teachers were hesitant at the start not knowing what the ‘right answers’ to my questions were or what the consequences of a wrong answer could be. I emphasised there was no such thing as a wrong answer and genuinely wanted to hear their personal views and perspectives.

School-A teachers were confident and more assertive, willing to criticise their seniors as well as praise them. In contrast, school-B teachers never criticised seniors and appeared positive about the support they received.

On the last day I was asked to, and did, a demo-lesson by the two senior teachers in school-A. I felt this was the teachers challenging me in a manner of ‘if you are researching it how well can you do it’. In school-B on the third day the senior teacher said the teachers wanted to talk to me. Expecting two or three teachers I was surprised to walk in on the whole staff hoping to get professional development on behaviour management. For me this signalled trust as well as a desire to learn. At the end of the last research day, I delivered a training session in which all teachers engaged.

3.5.1.2 Meaning, interpretation and uncertainty

I sometimes had to give a literal meaning to my questions, so when I asked what assessment meant I was met with blank stares. When I explained the kind of activities this may involve teachers opened up. While conducting the interviews, I was conscious I was adding my own meaning and weight to the teachers’ response, as well as value judgements, as noted in my field visit

notebook. So as is natural in conversation I would say things like ‘exactly’ or ‘you are so right’. With multiple meaning and interpretations, it can be difficult to avoid uncertainty, but by having semi-structured interviews I was able to follow up where there was ambiguity. I also offered the teachers opportunities to ask me questions.

What is worth noting is that the lack of training and experience and indeed the unfamiliarity with key terminology in all except school-A meant that the interviews were not prone to attributional bias (Muijs, 2012). The participants did not know what the ‘right answer’ was, so although they experienced discomfort initially trying to identify this, in the end they provided their own perspective (Muijs, 2012).

3.6 Reliability, validity and generalisation

Next, I consider the reliability and validity of my quantitative and qualitative data and of the overall case-study approach.

3.6.1 Quantitative data

My quantitative data has high reliability and validity. Reliability is a measure of consistency and refers to whether the results can be reproduced using similar methodology (Golafshani, 2003). Confidential OPM (2012) documents noted the steps they took to ensure statistical validity as well as reliability, including piloting assessment tools and multiple checkers for inputting data to ensure accuracy.

Validity is even more important than reliability as it provides confidence that the right things were measured (Biddix, 2017). Internal validity of quantitative data considers whether the right data was collected (Lewin, 2005). This allows a researcher to arrive at an explanation for their observations with confidence and is important in giving credibility to causal inferences based on the analysis of the data. Factors affecting internal validity include capturing accurate data, being able to track the same children over a period of time, taking a sample size large enough so that causal factors are not compounded by age or differing sample size. The validity of OPM data, a recognised evaluation expert in the international development field, was assured through the checks that were put

in place by DFID. A respected high-level, independent academic review panel was appointed by DFID to scrutinise OPM's methodology for data collection and analysis.

External validity is needed to ensure that causality claims applied to the sample population can be generalised to the wider population that the sample is drawn from (Lewin, 2005). OPM secured reliability and validity of their data through ensuring the sample was representative and randomly chosen at the household not school level.

I do not believe that the pilot or case-study schools children differ in any significant way from the OPM population. The children attending my schools are drawn from the same population of the poorest 20 districts in Karachi which my district is a subset of and registered to attend the schools my pilot and case-study schools are a subset of. Therefore, findings from my analysis of the OPM data are likely to apply validly to my schools as well as to the general population.

EFS assessment data's reliability and validity comes from their methodology and testing instruments, which randomly selected a sample of children in every EFS school and conducted assessments under similar test conditions. The tests were designed and piloted by assessment experts from UK and Pakistani universities with the needs of out-of-school children in mind, giving confidence and validity to the assessment tools.

3.6.2 Qualitative data

Issues of reliability, validity and generalisation are typically associated with quantitative data but principles, although contested, apply to qualitative data also (Golafshani, 2003; Cohen, et al., 2011). Validity refers 'to the integrity and application of the methods undertaken and the precision in which the findings accurately reflect the data, while reliability describes consistency within the employed analytical procedures' (Noble & Smith, 2017, p. 34).

Reliability is enhanced by the researcher being clear about the decisions they take which allows another researcher to arrive at comparable findings (Noble &

Smith, 2017). By setting out my methodology here and sharing my tools I increase the reliability of my findings. Golafshani (2003) notes that while some academics argue that reliability relates to measurement and, therefore, has no place in qualitative research others assert that demonstrating validity establishes reliability.

Validity of findings in qualitative research is about its quality and trustworthiness (Golafshani, 2003) but given that qualitative data is subjective and seeks to understand as opposed to measure, validity in this paradigm is seen as a matter of degree rather than absolute (Cohen, et al., 2011). I sought to increase validity by outlining my personal perspectives, experiences and possible biases and providing an account that is factually accurate describing what happened. Validity is enhanced by using the natural setting as the principle source of data and comparing across cases. By replicating across my two in-depth cases as well as pilot-schools and seeking similarities and differences across the sources (interviews, observations, field notes and learning-outcomes data) I secured greater theoretical validity, 'the extent of which research explains phenomena' (Cohen, et al., 2011, p. 181). Validity is also achieved by 'including rich and thick verbatim descriptions of participants' accounts' in my findings (Noble & Smith, 2017, p. 35).

A particularly relevant form of validity for this research is that of cross-cultural validity (Cohen, et al., 2011). I designed my study to explore teaching and learning in Karachi, however, my professional experience is rooted in England. Therefore, I considered whether to use my own definitions or meanings or base them on the culture I was in. I chose to use my own and clarify in discussions with participants as needed for the pilot which gave confidence in their relevance for the in-depth case-studies. I also considered the issue of whether instruments rooted in HIC can be applied in Pakistan. Given my belief that principles of good teaching are universal I approached my methodology with the principle that the same instruments may be utilised but was prepared to adapt them if this was not the case. The pilot study gave me confidence in the applicability of the instruments.

Classroom discourse, both of it and in it, are bounded by cultural and linguistic boundaries (Clarke, 2013). When seeking to describe practice, underlying principles and theories of learning situated in the culture should be considered. Clarke argues that HIC researchers may lack the pedagogical vocabulary to describe what they observe in other countries given their unfamiliarity with the language and learning theories being studied. For example, much HIC literature emphasises the importance of mathematical talk whereas far-eastern students believe speaking interferes with thinking. I am influenced by the premise that humans learn in similar ways and there may be common principles of effective teaching practices (Leech & Moon, 1999). However, I am mindful of Clarke's (2013, p. 23) caution that describing components of good practice across cultures 'remains a matter for empirical investigation'.

3.6.3 Reliability, validity and generalisability of a mixed-method case-study

In qualitative methods internal validity has greater significance than reliability (Cohen, et al., 2011) and in quantitative methods both are important. Validity in applied research case-study methodology is based on comparing and contrasting between several cases. My mixed-methods approach enhances 'powerfully' the reliability and validity of findings as a consequence of triangulating the evidence from different sources and from 'methodological triangulation' by replicating my approach in two schools (Cohen, et al., 2011, p. 195).

Having described how I acquired and collected data, and its reliability and validity, I next explain my approach to its analysis.

3.7 Data analysis approach

In this section I set out my approach to analysing quantitative and qualitative data, and the issues that arose.

3.7.1 Quantitative data analysis of OPM data

I used OPM's data to answer my first research sub-question, RQ1, regarding who attended LCPS-schools to provide an overview of students' characteristics, background and baseline learning-outcomes. This was important in order to set

the context for teachers' pedagogical behaviours, which includes their expectation of students.

I used SPSS to conduct a cross-sectional descriptive and inferential multi-variate analysis on the baseline data in order to describe the children in my case-study schools. I sought to identify differences between groups that were a sub-set of the sample population based on a range of variables, such as gender, ethnicity, type of school attended, language spoken and language of instruction, and characteristics of the household. Then I analysed information from assessment scores. Focusing on mathematics, I sought to identify through regression analysis the key factors that linked to student achievement in order to explore potential causality. In undertaking the analysis of the difference between mathematics scores of children in Karachi, I evaluated the size of the effect of different groups considering variables such as gender, home language and parental attributes.

The linear regression model I tested out is:

$$\text{Learning-outcomes} = a + b_1 * \text{type of school attended}_i + b_2 * \text{language spoken}_{2i} + b_3 * \text{gender}_{3i} + b_4 * \text{household's education level}_{4i} + b_5 * \text{occupation level}_{5i} + b_6 * \text{child labour} + \text{other socio-economic factors} + e$$

where a is a constant, b_i is a coefficient and i is a dummy variable.

I achieved reliability through explaining how I analysed the data, the tests I used and ensuring that if replicated the tests would provide the same results. I ran the same tests several times, using different methods to check I was getting the same answer. OPM had ensured that the sample size was sufficient enough to be able to undertake multi-variate analysis while still ensuring validity through sufficient statistical power when doing calculations.

3.7.1.1 Issues with the quantitative data

Although the OPM database was substantial, the version I had access to required cleaning as I found several errors during the analysis stage. Issues included replicated variables and lack of clarity as to who the respondents were as well as what the variable meant: for example, one variable was entitled

'access to media', but it was not clear if this was about the child having access to media or the household; and learning assessments data was recorded for children under two years olds. I made assumptions regarding who the source of the data was (in the example above I assumed it applied to the household) to address ambiguity and I deleted outliers from my analysis. Children had a choice to either do Sindhi or Urdu assessments: if they chose Sindhi, then Urdu should have presented as a blank rather than zero and vice versa. As this was not always the case, I cleaned the data to acquire accurate results.

3.7.2 Qualitative data analysis

Next, I set out how I analysed the lesson observations and interviews. The literature review and my professional experience set the 'purpose' of the observations, interview focus and the 'strategy' used to gather the evidence (Wragg, 1999, p. 77). I analysed my data against the five components (RQ3.1 planning and preparation; RQ3.2 classroom environment; RQ3.3 instructional practices; RQ3.4 independent practice and summative assessment; and RQ3.5 teachers as professionals) in my theoretical framework (Page 64) which I coalesce around three research sub-questions, RQ2, RQ3 and RQ4 (RQ1 is predominantly answered using quantitative data):

The values underpinning teachers' instructional and professional practices:

1. All seven of Shulman's (1987) knowledge bases inform teachers' *planning and preparation*. In this I include teachers' expectation of students and how their knowledge of students informs their work. I also linked this to teachers' views of teaching.

2. Teachers' knowledge of: educational goals, purposes and values; educational contexts; and students inform the classroom environment, including managing behaviour and aspects of communication, including teachers' ethic of care and approach to equity and inclusion.

The *instructional practices* teachers use to teach mathematics:

3. This includes: lesson framing; teachers' direct instruction including scaffolding, modelling and guiding practice (developing conceptual

understanding by making connections, using resources and addressing misconceptions and errors); their formative assessment practices including questioning. Linked to their values is how teachers share their space with students, diminishing their control. Communication is overarching theme within this.

4. Teachers' role during independent practice and their approach to homework. The school's summative assessment system and how this informs teaching.

The *institutional environment* that supports or hinders the development of mathematics teaching practice:

5. Teachers' sense of themselves as professionals, their view of it and how they feel supported; and interaction with other stakeholders, such as parents and other professionals.

However, for analysis these components needed breaking down into codes which I describe next.

3.7.2.1 Coding the lesson observations and interviews

I employed the same analytical approach to the in-depth phase as I had in the pilot phase, refining it according to my theoretical framework. This gave me confidence that the approach worked. Below I set out the approach in detail.

First, I converted all my notes from lesson observations and interviews, and transcribed my recordings into a single word document. I then employed the 'retrieval of text sequences' coding process to this document (Walliman, 2011, p. 133). I began by conducting pattern-coding, coding the text according to the five components listed above, looking for patterns across the data, and dissected these further into hierarchical sub-component themes (Appendix 4 sets out the full coding hierarchy). The top level was the research questions (RQ1 to RQ4); the second level was the five components from the theoretical framework (RQ3.1 to RQ3.5); the next level down included themes from the literature review (1a to 5c), then data from the pilot-schools and in-depth case-study schools.

The sub-components from the field data were developed using an open coding process (Cohen, et al., 2011). This gave me the flexibility to expand the codes through an inductive reasoning process to theorise teachers' values and instructional practices (Hamilton & Corbett-Whittier, 2013). For example, in the pilot interviews a clear sense of moral purpose emerged, to which I added religious inspiration as a sub-component. However, in the in-depth phase a sense of education transforming the locality also emerged which I then included as a sub-component of moral purpose. Another example was a code for 'lesson framing' which arose from the literature, but lesson observation notes showed lesson ended abruptly so I added this as a sub-component under 'lesson framing'. It was sometimes difficult to disaggregate key concepts as they were often interlinked, for example, when a teacher spotted students' error I had to decide whether this came under developing conceptual understanding, creating the right environment or creating mathematics fluency. I repeated the coding process several times, on each iteration refining my codes, clustering the text against the five components.

I analysed the in-depth lesson observations and interviews, linking the two together for each school, then looked across the schools for themes that emerged, and referred back to the pilot analysis, each time seeking similarities or differences (Cohen, Manion, & Morrison, 2011). I was looking for broad themes rather than precise quantitative number of factual or recall questions asked. Therefore, my analysis made statements such as 'predominantly, mostly or rarely' rather than quantifiable occurrences of each incident.

Using the same themes for the interview and lesson observations allowed me to link the two, seeking to draw patterns and linkages between observation and interviews. This was particularly useful when I was trying to understand why a teacher did something, for example, a teacher had prepared questions in students' books. I was able to link what she did in the lessons to what she said in the interview ('It helped with behaviour and focus'), coding it under planning and managing behaviour.

Finally, to discern between teachers with expert and novice practices within and across schools I drew up descriptors for each (see Appendix 5) based on the

literature review. This enabled me to describe the teaching I observed and the differences between practices with greater clarity.

To present the findings, I used the framing of the five components against the three sub-research (RQ3.2 to RQ3.4) questions listed above, articulating themes emerging from the coding, using excerpts from lesson observations and interviews in my write up. This gave me deeper insight, for example, lesson observation coding showed no differentiation and interview coding showed an emphasis on supporting lower ability students, mostly after lessons. This led to findings that in-class differentiation was not a well-developed aspect of direct instruction.

3.8 My role as a researcher

In this section I outline my role as a researcher and how my professional background informed my approach, my connectivity with research subjects, and how I aimed for a pragmatic approach to data gathering, seeking objectivity but recognising this is not always possible.

My research methodology required me to interview teachers and senior leaders, and observe teaching in Karachi's LCPS-schools. My professional training and experience led to a knowledge gap between me as the researcher and the subject under study. As a professional inspecting and informing policy in England, I was researching in settings where poor parents sent their children to be taught by inexperienced, poorly qualified, low-paid teachers (Andrabi, et al., 2013).

Although having left DFID in early 2014, I had been close to DFID's work on LCPS-schools. This had benefits such as gaining access to data but also drawbacks such as greater potential for bias. However, my research was conducted after the programme had concluded and four years after I had left DFID. Therefore, the case-study schools were no longer under DFID's indirect influence.

I wanted to be a neutral observer, objectively studying teachers and students, and their interaction with each other (Stark & Torrance, 2005). I sought to

observe as an outsider but at times I also used my professional experience to judge whether the children were given cognitively demanding work. For example, I would ask questions that were harder than the ones the teacher set and see if the students could tackle them. In this way I was not just observing but co-constructing evidence (Jones & Somekh, 2005). Given that the literature identified cognitively demanding work is key, I felt this was a legitimate stance to take. Consequently, my pragmatic stance allowed me to act both as a qualitative researcher emphasising the 'interpretive, value-laden, contextual' nature of knowledge and a quantitative researcher aspiring for 'realism, objectivity, causal explanations and universal truths' (Greene, et al., 2005, p. 275).

I influenced the dynamics in the classroom by being present. Teachers perceived an important visitor was attending because I was received by the headteacher in school-A and headquarters staff. This will have added a dimension not normally experienced in the classroom. A powerful example was on my pilot-school visit where a girl started crying in the class. When I asked another student why she was crying the student responded that the teacher was keeping the whole class in later than normal so I could observe her teaching. Horrified, I asked the teacher to let the students go home.

I sought to minimise the observer effect by being conscious of how I might be perceived and as such dressed, spoke and interacted in a way that downplayed my perceived powerful position. Despite this attempt in each school teachers asked me to share my professional experience, in school-A by doing a demo-lesson and in school-B by running a training session.

I sought to take the stance of an outsider but I was also an insider as my ethnic heritage is Indo-Pak and I speak Urdu, albeit hesitantly. Although British in how I see myself, my ethnic heritage enabled me to act as an insider and merge into the setting in a way a White British researcher would not have been able to (Wragg, 2002). I used this to my advantage, dressing in Pakistani clothes to blend in and minimise a disruptive presence in the classroom. Being allowed into someone's school and classroom is a privilege and so I was very respectful of the opportunity.

I aimed for internal objectivity by doing the same thing in each of the schools. However, as my field notes show I had emotional responses to what I observed: sympathy and admiration for a headteacher who used her initiative to meet the costs of children's uniform and frustration in lessons where teachers spent most of the time marking. I was conscious of this response and sought to mitigate it by using an objective way to record and analyse findings. In both case-study schools I was shocked at the depth of poverty the students and teachers lived in and the substantial demands on the young teachers in their daily lives, as well as the lack of systemic support for the schools, particularly school-B. I sought to mitigate the effects of my biases and influences by being conscious of them, applying my tools consistently and by also accepting these as part of the research process.

I was conscious about maintaining objectivity when making decisions regarding the quantitative evaluation. When deciding what variables to include in my statistical model I made value decisions about what I considered important based on the literature review. Therefore, I analysed gender, employability and type of schooling. Nevertheless, even here pragmatism was needed as researcher neutrality is compromised even when using mathematics for theory construction, for example, by analysing certain variables and not others (Garratt & Li, 2005).

3.9 Ethics

Next, I set out how my methodology met ethical research standards, particularly important given I was working directly with children in high security areas.

As I was using secondary data, the ethical issues regarding the quantitative data were the responsibility of OPM, the primary gatherer of data, and DFID, its commissioner. I secured permission from DFID to have access to data and will share findings with them, although I retain intellectual ownership. My role was to ensure ethical conduct in data analysis and reporting findings that are true, unbiased and replicable. The impact evaluation could have been a potential source of ethical issue, for example, if my findings contradicted OPM's. However, as my methodology is robust and stands up to scrutiny, the fact there

are two independent analyses of the same data helps to add rigour (Hamilton & Corbett-Whittier, 2013). I fed my concerns regarding the data issues to DFID.

Ethical concerns could have arisen during lesson observations. Karachi is a city I can blend into. While I was open about my role and background, my appearances made it easier for students and teachers to mostly behave as per normal (Wragg, 2002). In terms of access to children, as a professional working in education I have security clearances by the UK government and was never alone with children.

I endeavoured in all my interactions during the course of this research to be respectful. I took steps to ensure schools had the right to refuse engaging in the research and give informed consent by explaining their rights to them, stating there will be no consequences of refusal. I shared my research information sheet with teachers and have consent forms which teachers signed (Appendix 6). I was open about my research and my role and its limitation, ensured confidentiality and reported findings in a way that anonymised the schools, particularly given the security situation (Jones & Somekh, 2005). In some countries, knowledge of foreign funding for organisations can lead to backlash (BBC news, 2016).

An important aspect of the applied research approach is the respondents' review of the draft report (Jones & Somekh, 2005). However, in this I am restricted because of teachers' unfamiliarity with English and my limitations in getting the thesis to them given internet connectivity and postal service issues for the teachers I interviewed. However, I plan to share findings with DFID to inform their policymaking and a short report with the case-study schools.

3.10 Summary

In this chapter I outlined the research approach I took, one of mixed-methods case-study model, and the methods I used to collect and analyse the data. This included quantitative data about the school population and qualitative data from field visits. Using a coding method based on the theoretical framework I developed, I was able to analyse the data around components of effective teaching.

In the next chapter I discuss my findings.

Chapter 4 Findings

4.1 Introduction

In this chapter I present my findings in answer to my main research question: what is mathematics teaching and learning like in Karachi's LCPS primary schools?

I organise the findings according to the five components of effective teaching in my theoretical framework (Figure 2.1 on Page 64). This is based on Alexander's (2008, p. 77) framing of teaching as having structure and form; situated in, and governed by, space, time and patterns of student organisation; and undertaken for a purpose.

Section 4.2 sets out the space, time and patterns of student organisations in my two case-study schools. Then to answer the main research question, I present the findings to the four sub-questions, RQ1 to RQ4, in four thematically organised sections:

- Section 4.3: RQ1: Who are the students attending Karachi's LCPS-schools?
- Section 4.4: RQ2: What values underpin teachers' instructional and professional practices? This articulates teachers' purpose, ideas, values and beliefs.
- Section 4.5: RQ3: What instructional practices do teachers use to teach mathematics? This expands on the structure and form of teaching and is organised to reflect components of the theoretical framework: RQ3.1 planning and preparation; RQ3.2 classroom environment; RQ3.3 instructional practices; and RQ3.4 independent practice and summative assessment.
- Section 4.6: RQ4: How does the institutional environment support (or hinder) the development of mathematics teaching practice? This incorporates component RQ3.5 (teachers as professionals) of the theoretical framework.

I draw on OPM's quantitative data from nearly 4800 children in Karachi's 20 poorest districts where my case-study and pilot schools were located, and qualitative data from five pilot-schools (PS1 to PS5) and two in-depth case-

study schools (school-A and school-B) using evidence from 34 lesson observations, 28 interviews and field notes.

Unless otherwise stated, qualitative findings are based on evidence from the two in-depth case-study schools, school-A and school-B whose teachers are denoted by the suffix -A or -B. When basing findings from my full evidence base I refer to schools in general, or specifically to differentiate between the pilot-schools I use suffix -PS1 to -PS5 to allude to teachers in each of the five pilot-schools; pilot-school 4 is school-B.

4.2 Space, time and patterns of student organisation

I begin with presenting the infrastructure of two case-study schools to set the context in which LCPS teachers teach and a background for interpreting the findings.

4.2.1 Overview of school-A

Built in the early 2000's, school-A is a mixed primary school for around 400 children aged 5 to 11 located on a main road in a poor, dusty area of Karachi. It is part of a large, popular, national chain of schools run by a charitable foundation whose aim is to provide quality education to the poor. It is funded almost entirely by philanthropy. The chain charges a monthly means-tested fee of between 50Rs (£0.27) and 440Rs (£2.38) per child. Teachers' age ranges from 18 to 50, qualification ranges from graduate to intermediate (equivalent to A-level) and monthly salary ranges from 8,000Rs (£43.20) to 12,000Rs (£64.80).

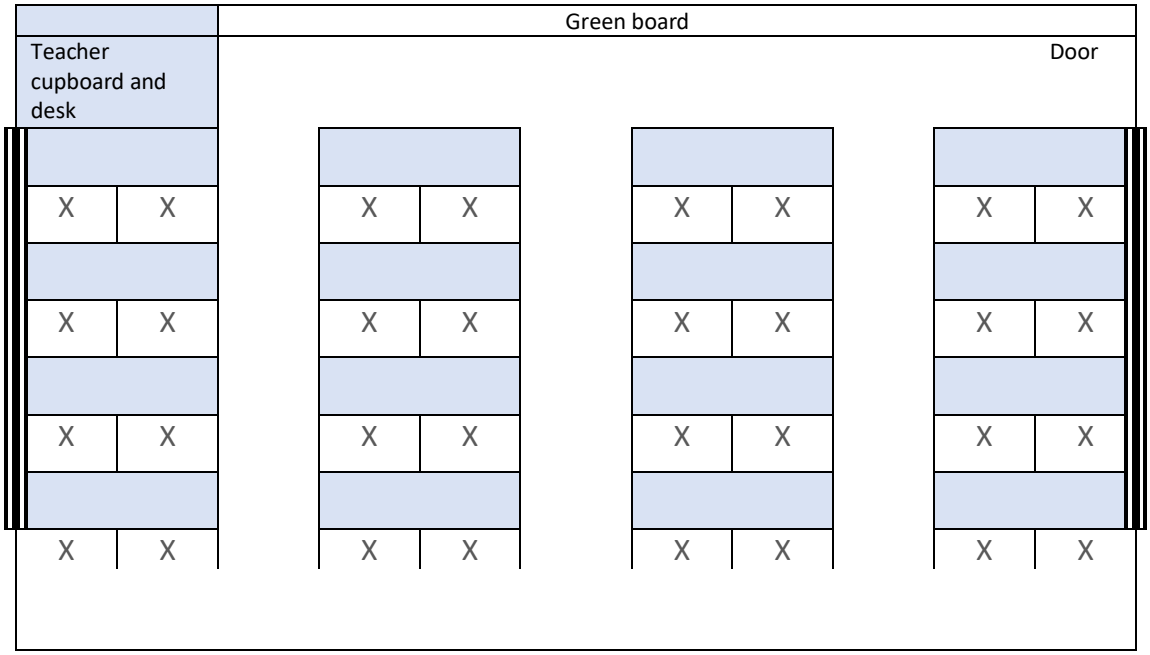
School-A is part of a campus comprising a morning shift of a primary and secondary school followed by a similar afternoon shift. The primary headteacher oversees 14 teachers, two of whom are senior teachers, Amna-A and Huda-A, who as subject specialists teach mathematics from class 2 onwards.

School-A's day, comprising five lessons of 40 minutes each with a 20-minute break midway, begins with a whole-school assembly at 0830 and ends at 1225 for students. Teachers have a 'zero-period' until 1.05 for planning, marking or providing additional support to students. There are two mixed-ability classes in

each year group, Kindergarten (KG) to class 5, with around 34 students per class.

The school building is an oasis within the locality with classrooms arranged over two floors around a beautiful central courtyard filled with plants. Classrooms are clean, spacious, bright and airy with attractive displays of children's work. Wooden desks and chairs for students are placed in neat columns, theatre style, for class 2 onwards (see Figure 4.1). Younger classes are seated in groups.

Figure 4.1 A typical upper-primary classroom in school-A



Each classroom has a long blackboard, a cupboard and a teacher's desk. Two walls of windows encompass each classroom, allowing air to circulate and a fan which is subject to the inconsistency of power supply in Pakistan. In the staff room, a large table is at the centre around which all teachers sit. Outside there is a very large sandy playground.

The students are neatly and smartly turned out with clean and crisp uniforms. Girls, if they have long hair, wear them in neat plaits and boys wear their hair short and neat.

4.2.2 Overview of school-B

Established in 2008, school-B is a mixed, combined primary and secondary school (from nursery to year 10) for over 1100 children, aged 3 to 16. It is located in a very poor area of Karachi deemed a ‘katchi-abadi’ (slum) and backs on to a canal full of rubbish as far as one can see. The owners, a married couple, live above the school with the wife serving as the headteacher. School-B’s fees at 500Rs (£2.70) per month are higher than school-A’s (orphans and the poor pay half) whereas teachers’ salaries are lower, ranging from 3000Rs (£16.20) to 5000Rs (£27.00) with the three senior teacher earning 8000Rs (£43.20).

Senior teachers are responsible for the pre-primary (nursery, KG1 and KG2), primary (classes 1 to 4) and secondary schools (classes 5 to 10). School timings are similar to school-A. There are 26 teachers in the primary school including two who teach mathematics. Most are around 16 to 18 years old (one joined when she was 14, another at 15), beginning teaching after passing their matriculation exams (equivalent to GCSE) others have the ‘intermediate’ A-level equivalent qualification. School-B is typical of a LCPS-school described in the literature (Bau & Das, 2017).

The school comprises four interconnected buildings. The one owned by the couple is purpose-built, cramped but well-organised over three floors around a very small courtyard with room for only one person to walk along the hallways. The other three buildings are rented and haphazardly connected. The staircase is walled on one side with no barrier on the other. There is a small playground covered by a large tree.

Most classes are dark and crowded, without window panes or doors, cold in winter and hot in the summer. They are separated by half-walls, making it very noisy, especially when other classes are reciting loudly. Some classes are fully open plan or interconnected so the only way to go to one is through another. Seating is arranged in a similar fashion to school-A, but far more cramped with little room for a person to move between the desks. Classes do not have a teacher’s desk and there is no staffroom. The headteacher’s ‘office’ is at the

back of one classroom, adjoining four others. Despite all this, the school is well cared for and clean, an oasis in the surrounding area.

In addition to school-A's reputation and the package on offer (medical benefits and transport to and from school) teachers were attracted by its purpose, 'They will take anyone, a street child, and give them a good education' [Shazia-A]. In contrast, school-B struggled to recruit because of its location in the slums but they appeared to grow their own teachers with at least six being ex-students. The headteacher explained, 'Those who are able to leave, leave and never come back'.

School-B is more representative of the other four pilot-schools.

4.3 The students attending Karachi's LCPS-schools

Having described two LCPS-schools in Karachi, I present the findings of my first research sub-question, RQ1, as to who the students likely to be attending LCPS-schools such as these are. This provides contextual background for their teachers' professional and pedagogical practices. I report on the children's households, their schools, learning-outcomes based on their characteristics and I conclude by presenting a statistical model for the relationship between children's characteristics and their learning-outcomes in mathematics. The data analysis and descriptive statistics that informs this section can be found in tables A7.1 to A7.61 in Appendix 7; the relevant table is referenced in brackets in the text below.

The analysis in this section is derived from assessment information in mathematics, English and Urdu from 90% of the 4,785 sample population children collected by OPM (2015a) (A7.46).

4.3.1 Children and their households

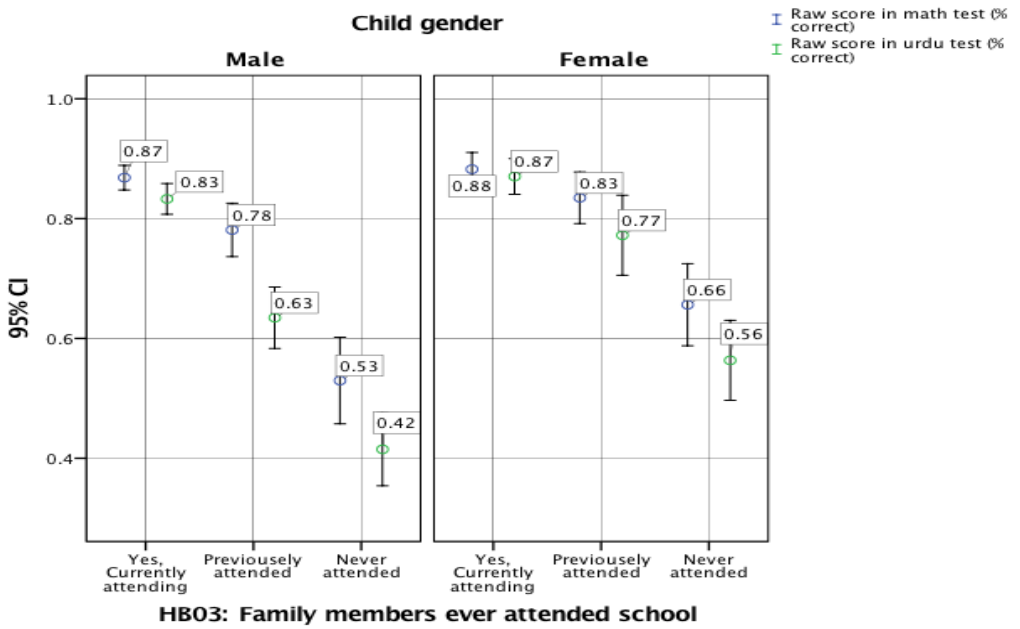
Over half the families owned their predominantly one- or two-bedroom houses, suggesting overcrowded accommodation given the large average household sizes of eight people, with around half the people in each household under the age of 18 (A7.4-6; 7.13-14). A surprisingly high proportion had access to a TV (94%) but the proportion with access to print media was low (16%) (A7.15-17).

Suggesting changing attitudes towards education, less than 2% of the adults reported they did not approve of schooling whereas 29% reported they had not gone to school because their own parents had not approved (A7.18-19). This likely reflects why only a third of the household heads had completed primary education with another third having received no formal education (A7.8), echoing UNESCO's (2012) findings. Less than a third of adults said they could read (A7.9). This low education level is reflected in employment status. Over half the men, and over 40% of women, worked as casual labourers (A7.10-12). These findings echo findings from the school field visits discussed in Section 4.4 below.

Educational experience in the family makes a difference to whether children go to school. Unsurprisingly, if other family members attended school then children were far more likely to also attend. If household members had never attended school, then the likelihood of the child attending was minuscule (A7.53-54). Figure 4.2 highlights a clear relationship between the family members' education history and children's learning-outcomes in mathematics with boys worse affected than girls if there was no history of education in the household. Furthermore, regardless of the quality of schooling children receive, it makes a difference: if children had previously attended school they were far more likely to have higher learning-outcomes than if they had not.

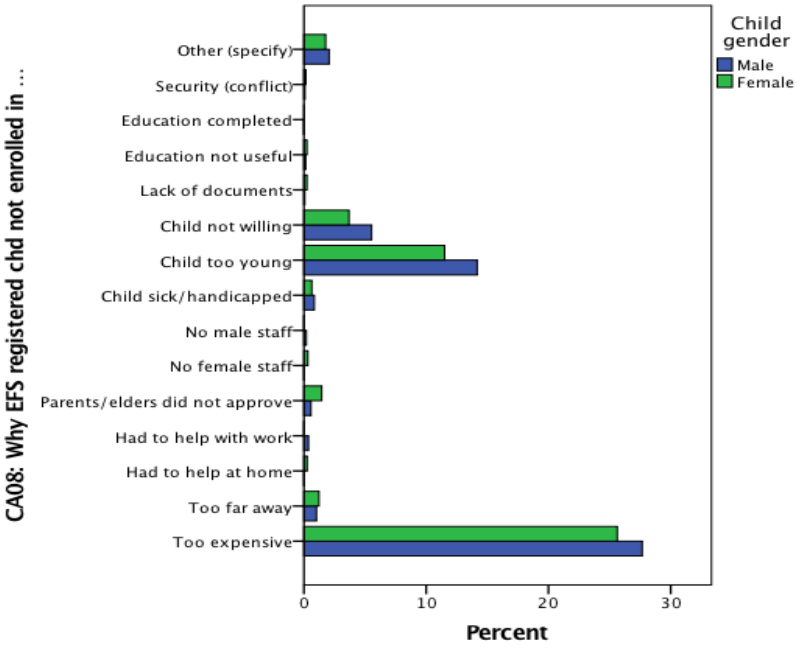
An independent sample t-test is 99% significant and shows a far higher score was achieved in all subjects if there were household members currently in education than if no family member ever attended school (A7.55). This is perhaps linked to aspiration setting. While a hypothesis could be that other household members in education helped children at home, nearly a half reported they did school-work without help,13% received help from siblings and 10% from their mothers with fathers largely absent from this task (2%) (A7.43).

Figure 4.2 Attainment in mathematics and Urdu compared to household members' education history



There was a slightly higher proportion of boys than girls registered by their parents for DFID funding (A7.2) perhaps reflecting parents' greater interest in educating sons (Aslam, 2009). Although the vast majority of children were above five years old and had a school within a kilometre of where they lived only 56% had been enrolled, indicating that physical access was not the barrier preventing parents from schooling their children (A7.21-22). The most common reason cited for non-enrolment was expense (Figure 4.3). This suggests that subsidies removing the financial burden of education can be transformational in providing access to education. The second highest reason for non-enrolment was the perception that children were too young.

Figure 4.3 Respondent's reason for why their children are not in school



While over 60% of both girls and boys undertook household chores, with girls contributing an hour more than the boys' four hours, very few parents cited this as a reason for non-enrolment (A7.23). It also appears that child labour was not a key factor in preventing children from being schooled (or that it was underreported). Under 7% of children were reported to be engaged in child labour (A7.24) with boys working for an average of 15 hours per week compared to girls' seven hours (A7.25). The gender pay gap exists here too: 70% of boys were paid in cash as opposed to 31% of the girls (A7.26).

4.3.2 Children's schools

In this section I present parents' and students' views of the school children attend and explore differences according to school type. Although the sample is likely biased because the children were all registered initially by motivated parents hoping to receive a voucher to attend LCPS-schools (only half subsequently received a voucher), analysis by school type is useful[1]. Given that

[1] Data was available for five types of schools: government schools disaggregated by their language of instruction, LCPS-schools defined as private schools in the dataset, deeni (religious) madrassa, non-governmental organisation (NGO) schools and non-formal basic-education which are community run informal schools.

it was not clear from the data which type of schools charged fees or not, I focused my analysis on government versus LCPS-school ('private schools').

Reflecting the rapid rise of LCPS-schools (The Economist, 2015), of the children in school over two-thirds attended a LCPS-school with only a quarter attending a government school (A7.47-49). An independent t-test shows that there is not a significant difference between learning-outcomes in mathematics of children attending any type of government school or LCPS-school (A7.49). This may be a result of the skewed sample so while there may be a difference in the overall population, for this sample of motivated parents, at the start of schooling children join with similar levels. An indication of this motivation and commitment to education is that nearly 20% of the children had a tutor, surprising given the socio-economic circumstances of the families (A7.43). It may also be the case that given this is baseline data, perhaps the type of schooling has not yet had a chance to make a difference as national surveys show that children attain higher in private schools (ASER, 2016).

Parental perception of educational quality is important when they choose schools (Ashley, et al., 2014). For those with children in school, over three-quarters of parents noted satisfaction with the quality of their children's teachers and the school's infrastructure (A7.27-28). Of those not satisfied, teachers' poor attendance followed by their lack of qualifications and lack of subject knowledge were the highest contributory factors (A7.29-32). This shows a discerning range of concerns given the parents' own educational background noted above.

This high parental satisfaction is in contrast to children's view: less than a third of whom reported their teachers taught them well and under a fifth reported they were interested in their studies. Factors children liked least were teachers beating them and other children fighting but less than 8% reported being bullied and teased (A7.34-35). While only 3% of parents felt teachers' physical or verbal abuse was a concern, nearly a quarter of the children felt this to be an issue with boys far more likely to experience beating than girls (A7.29-32).

Children attending LCPS-schools were more positive about their educational experience than any other type of school attendee. Nearly half of the LCPS

schoolchildren reported their teachers taught them well, were friendly and helpful; and a far higher proportion felt proud to be in school than in any other type of school (A7.36). In contrast, less than a fifth of the government schoolchildren felt they were taught well. This may explain why LCPS-schools are growing at the expense of nominally free government schools.

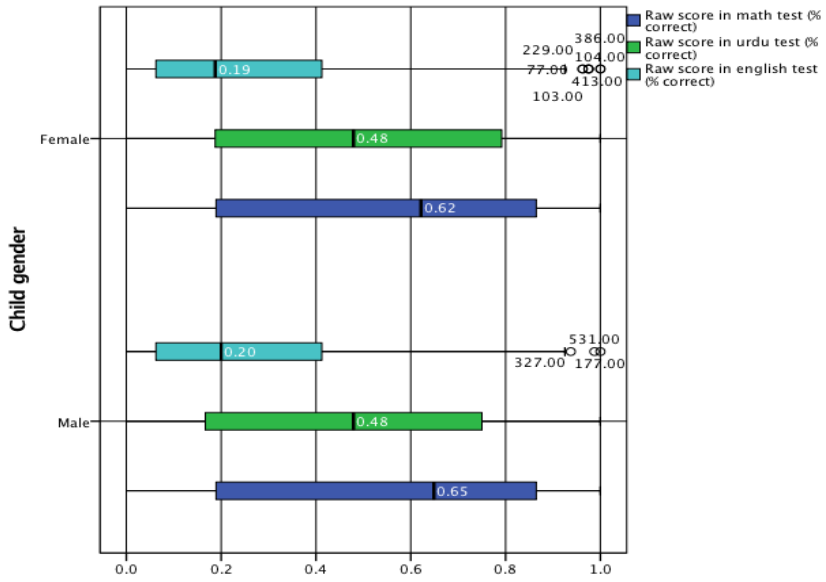
Children's aspirations were high and the vast majority had a career goal. Over a third wanted to be a doctor or engineer (A7.44). Given that the social norm of doctor/engineer is a measure of greatness, this likely reflects a desire to do well rather than to actually do these jobs. Gender differences were marked in some occupations but not in others (A7.45). While only one girl wanted to be a full-time parent, over 40% wanted to be teachers compared to only 8% of the boys, reflecting traditional societal acceptability of teaching as a female-friendly occupation. A higher proportion of girls than boys wanted to be doctors or engineers.

While a quarter were informed of their children's progress through parent meetings, only 13% of respondents had report cards from the school to indicate their children's progress (A7.39-42). This is a very low percentage given research shows report cards can have a positive impact on learning-outcomes (Andrabi, Das, & Khwaja, 2016). Just under half of the respondents felt their children were performing well at school, with girls thought to be doing better than boys; over a tenth reported their children were performing poorly (A7.37-38).

4.3.3 Learning-outcomes by children's characteristics

As learning-outcomes data was available for mathematics, English and Urdu, it is interesting to compare the three subjects. Mathematics scores are significantly higher than Urdu and English, with a statistically significant difference between the scores in all three subjects (A7.50-51). Given the difficulty in finding teachers able to teach English and lack of exposure to English language in the sample population, this is not a surprising finding. However, an ANOVA test at 99% confidence shows there is no statistically significant difference between the genders in any subject (Figure 4.4).

Figure 4.4 Median test scores by gender in mathematics, Urdu and English

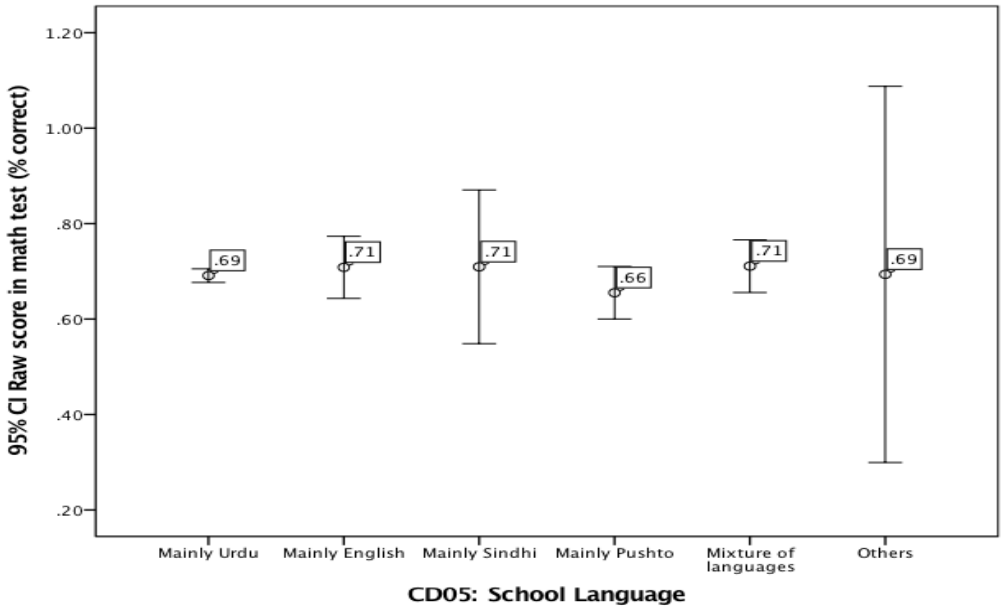


A correlation analysis shows a high positive correlation between the three subjects (A7.51). Performance in mathematics is a good indicator of performance in Urdu and English. A bivariate regression analysis provides the following relationships, statistically significant at 1% (A7.52):

- A one-point increase in mathematics score signifies a 0.83 increase in Urdu score
- A one-point increase in mathematics score signifies a 0.51 increase in English score.

The language spoken at home has an impact on mathematics scores. Disregarding groups of less than eight students due to small sample size, an ANOVA test shows that those who spoke Urdu at home performed the highest in mathematics (A7.56-58). In contrast, Figure 4.5 indicates that the language of instruction does not have a great impact on mathematics scores with surprisingly little variation in students' performance except where the language of instruction is Pushto, which did indicate significantly lower mathematics scores. However, this may be a result of other factors asides from language such as greater poverty levels in this community or they may be recent internal migrants.

Figure 4.5 Children's mathematics scores according to the schools' language of instruction



4.3.4 Factors affecting children's learning-outcomes in mathematics

Next, I present the factors which had the biggest impact on children's learning-outcomes in mathematics. I explored this by building a regression model with various household and children related explanatory factors, comparing the adjusted correlation score figure, r^2, and conducting significance tests (A7.61). Figure 4.6 summarises the factors I considered and how I built the model. If P-value is less than 0.01 or 0.05 then we can reject null hypothesis at the 1% or 5% significance level that there is no relationship between mathematics scores and the independent variable.

*Figure 4.6 A list of dependent variables and the goodness of fit with the mathematics scores (** denotes significance at 1%)*

Independent Variables	Coefficient	P-value	r^2, Goodness of fit value	% difference	The variable explains % difference in mathematics scores
Child's gender	-0.07	0.527	0.000	0%	No effect
Age of child**	0.077	0.000	0.342	34%	Substantial effect
Child's home language	0.000	0.579	0.000	0%	No effect
School's language of instruction	0.001	0.901	0.000	0%	No effect
Child ever been enrolled**	-0.354	0.000	0.253	25%	Substantial effect
Type of school attended by child	-0.001	0.538	0.000	0%	No effect
Family members attended school**	-0.134	0.000	0.208	21%	Substantial effect
Adult's Highest class passed	0.000	0.777	0.000	0%	No effect as to how long the adult attended school
Parent can read**	-0.229	0.000	0.214	21%	It appears that it is the ability to read that has a greater effect rather than the class passed
Parent work for pay: yes/no	0.075	0.474	0.018	2%	Surprisingly this did not have an effect
Parent's main occupation**	0.082	0.009	0.644	64%	It is the type of work that is done by the parent that has a substantial effect
Parent's view of child's current performance	-0.053	0.000	0.037	4%	Little effect
Parent's view of what child will become	-0.002	0.268	0.002	0%	Surprisingly the parent's aspiration correlates little with mathematics scores
Help with school work	0.000	0.771	0.000	0%	Having help with work also makes little difference to the mathematics scores
Access to print media	-0.086	0.000	0.008	1%	Little effect
Child engaged in labour	-0.070	0.002	0.002	0%	Little effect

Based on the variables listed above I developed a model that demonstrated a relationship between certain variables and mathematics scores (Figure 4.7). My conclusion is that the factors that explained 48% of children's mathematics scores are their age, the language spoken at home and whether they had been previously enrolled in school (A7.61). I stopped adding variables when the explanatory percentage difference was unaffected by the combination of variables. This model is statistically significant at 99% and all the variables separately are also significant at the same level.

Figure 4.7 SPSS output for multivariate regression of mathematics scores

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.693[a]	.481	.480	.25009

a. Predictors: (Constant)

Coefficients[a]

Model	Un-standardised coefficients		Standardised coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.424	.018		23.015	.000
CA04: Child Age	.065	.001	.492	43.548	.000
CA05: Child Language at home	-.001	.000	-.029	-2.658	.008
CA06: Child ever been Enrolled	-.270	.008	-.383	-33.921	.000

a. Dependent Variable: Raw score in math test (% correct)

The model for mathematics score =

0.424 + 0.065*child age – 0.001*language at home - 0.270*child ever been enrolled.

This model predicts that, keeping the other two variables constant, an increase of 1 year in the child's age the mathematics score will increase by 6.5 percentage points; and if a child has not been enrolled in school previously their mathematics score will decrease by 27 percentage points. This is a substantial difference. The language spoken at home adds to the model but its impact is difficult to quantify given the wide range of languages spoken.

4.3.5 Summary

In summary, the data shows family attitudes are likely changing with parents much more supportive of their children attending school than their own parents had been. However, the expense of schooling is the biggest factor holding parents back from sending their children to school. Children have high aspirations for their future despite their parents' own limited education. Family circumstances mattered: if others in the household attended school then this had a significant impact on children's learning-outcomes in mathematics.

Children were more likely to enjoy attending LCPS-schools than government schools but there was no statistical difference between learning-outcomes in mathematics in the two school types at baseline. Nearly half the difference in learning-outcomes in mathematics was affected by whether children had been enrolled in school before, their age and the language they spoke at home.

Having presented the characteristics of students likely to be attending my case-study schools, I next discuss the values that underpin their teachers' practices.

4.4 The values informing teachers' instructional and professional practices

In this section I present findings in relation to my second research sub-question, RQ2: the values that inform LCPS teachers' instructional and professional practices. As set out in the theoretical framework (Figure 2.1 on page 64 and reproduced below), these are the purpose, ideas, values and beliefs by which teaching is informed, sustained and justified. It includes knowledge of educational contexts, which in this case is of financial deprivation, both of students and teachers.

Four key themes emerge in relation to values and ideas that inform teachers' practices about teaching poor children: respect from their communities earned as a result of where they taught; personal fulfilment that appears to contribute to teachers' expectation of students; the importance of nurturing students through forging connections with them; and, finally, how this nurturing manifests itself through a strong ethic of care to counter the context of deprivation which their students face.

Figure 2.1Theoretical framework for teaching and learning

<table>
<tr><td></td><td colspan="3">What is mathematics teaching and learning like in Karachi's low-cost private sector (LCPS) primary schools?</td></tr>
<tr><td rowspan="2">RQ4: Institutional environment</td><td>Space, time & patterns of student organisation</td><td>RQ2: Purpose, ideas, values & beliefs by which teaching is informed, sustained & justified</td><td>Teaching has structure and form (RQ3)</td></tr>
<tr><td>To be studied empirically:
- School infrastructure
- School day
- Class sizes</td><td>RQ1: Knowledge of students:
Perception of students and parents

RQ2: Knowledge of educational goals, purposes and values, and contexts:
- Expectations of students
- Inclusion and equity
- View of teaching and of mathematics

RQ3.3a. Communication:
initiation/response/feedback
Mathematical communication

Exhibiting professionalism</td><td>RQ3.1. Approach to lesson planning and preparation
Knowledge of:
a. Content
b. Curriculum
c. Pedagogy (general & content)
d. Students
e. Adapting teaching
f. Planning use of resources (RQ3.3g)
g. Planning and making use of formative (RQ3.3d) & summative assessment (RQ3.4b)
RQ3.2. Creating a positive classroom environment
a. Ethic of care
b. Developing affective relationships
c. Behaviour for learning
d. Rules, routines and rituals
RQ3.3. Establishing effective instructional practices
General Pedagogical knowledge
b. Lesson framing (orientation)
c. Direct instruction, scaffolding learning & guided practice
d. Formative assessment
e. Questioning
Pedagogical content knowledge
f. Developing conceptual understanding
g. Use of resources
h. Making connections
i. Dealing with errors
RQ3.4. Providing independent practice and using summative assessment
a. Homework
b. Summative assessment system
c. Remedial classes
RQ3.5. Acting as professionals
a. Professional character
b. Commitment to continuous improvement
c. Relationships beyond the classroom (colleagues, parents, influencing policies)</td></tr>
</table>

4.4.1 Respect informing teachers' choices

Respect within the community and within the family was relevant to teachers' choices of why they taught and where they worked.

> 'Every nation is educating their children so teaching is considered respectful. People are more aware now. Even if they are not educated themselves they want their children to be' [Nighat-A].

The teachers came from religiously conservative backgrounds with the vast majority covering their faces outside school. However, the standing of these schools in the local community provided economic opportunities for teachers they may otherwise not have had. The teachers were unanimous in their appreciation of the safety and freedom the intentionally all-female faculty gave them, enabling familial permission to work. Both headteachers said while generally teachers do not have respect, working in their school rendered it a respect-worthy, honourable profession. Nighat-A, who began teaching for financial reasons after her parents passed away, explained how teaching raised her standing in her conservative community, overcoming their suspicions about a female in the work-place:

> 'Before I did not have status. I didn't have respect from my community. I hold the izzat (honour/respect) of my family in my hands…The community would question where is she going...but community attitudes have changed. Now I am ba-izzat (with respect) because of what I do.'

4.4.2 Personal fulfilment and pride

Personal fulfilment from teaching and a sense of pride in their students' accomplishments was a strong theme. This seemed to drive teachers' expectations of students, including of out-of-school children. They believed these children were able to learn and succeed.

> 'The children who didn't go to school catch up really quickly because they are eager to learn themselves. When they saw other children going to school, they also wanted to go. They felt they were missing out. Now that they are a bit older they want to learn even more' [Hala-PS1].

Teachers in all schools were very cognisant of the barriers students' faced such as: homelessness and overcrowding; child-labour; and family circumstances such as mothers leaving or passing away. Many relished addressing these challenges deriving personal fulfilment from doing so.

Teachers' own difficult financial circumstances contributed to their entry into the LCPS, often at a young age. Although it was not their first choice of profession, it appeared that the experience of teaching warmed them to it with many reporting they liked it. Numerous examples emerged of teachers' personal commitment and their intrinsic motivation to do well for students and to improve themselves as professionals. Amna-A, who began teaching at 18, presented a common account, 'First, I was teaching because it was a *majbori* (necessity), now it is my *shoq* (pleasure/hobby)'.

Students' achievement, for the teachers, led to pride in the school's achievements. Tasleem-B proudly stated, 'Our children go far; our matriculation children get positions…we give them the best education and improve their futures. The children make the school's and the parent's '*naam roshan'* (name in light)'. Amna-A compared her school's students with elite private schools, noting 'Our children are more confident, and they understand more. Our children can explain, deliver, define'. This is significant as it indicates teachers' belief that a transformative education enables underprivileged students to achieve beyond their wealthier peers.

A reciprocal relationship between teachers' personal fulfilment and students' attributes appeared to drive teachers' expectations, 'We are motivated by the children, they work hard so we have to too…Our children are extraordinarily talented' [focus group-A]. This reciprocity was also linked to students' learning-outcomes, 'I like it when children learn. I feel I have given something, done something' [Amna-A]. There was also an intergenerational and communal aspect to teachers' ideas, 'Our parents work hard and our children should go beyond them. As you study you go far, the neighbourhood improves' [Noor-B]. However, sometimes, teachers own circumstances set the boundaries of their expectations, resulting in poverty of aspirations. 'We change children's behaviour, their attitude…Our children go into good job in factories' [Hajra-B].

Nevertheless, in the same school Noor-B signalled greater ambition, proudly stating, ‘My students become doctors. I laid the foundation.’

Personal fulfilment rooted in an Islamically inspired perspective of teaching was explicitly stated in all pilot-schools, including school-B. Capturing a common view, Tasleem-B felt teaching was on a ‘very high plane… it is next to the prophet…no one is better than a teacher’. Zaina-B explained ‘God has given us a status [as a teacher]. Society should see we have a special status. We have the prophet’s profession…an elevated, spiritual status.’

4.4.3 Forging connections to nurture students

Teachers articulated their role in nurturing students through forging personal connections with them. This appeared to be an explicit belief based on the concept of being in loco parentis going well beyond a transactional relationship of teacher imparting knowledge to students. Hajra-B articulated a commonly held view of teachers, ‘After parents, comes the teacher’. She explained, ‘We have to think that they are our children…we should treat them with love. We guide them. We have to see their problems as ours’. Teachers noted the importance of connecting with students through ‘good attachment’, ‘being caring’ and a ‘*hamdard’* (someone who shares pain/is empathetic), seeking to ‘understand their problems’.

As well as noting that children should see teachers as friends, they saw themselves as role-models, noting children ‘should want to be like her’ [Shazia-A]. This manifested itself in range of ways including modelling professional standards such as punctuality, arriving before students and leaving after them as well as affective behaviours such as how to speak. ‘The teacher has to have good behaviour herself, she is the ideal, even her anger has to be controlled so children can learn from her’ [Shazia-A]. She was delighted when parents told her that students copied the way she talked.

4.4.4 Ethic of care to promote equity

In addition to nurturing students, teachers across the schools had a clear view of how this nurturing needed to function in the context of their community’s deprivation. The ethic of care underpinning teachers’ focus on equity was seen

in powerful accounts of their role as developing children holistically, actively working to move them beyond their life circumstances and have long term impact.

> ‘We realised that the children’s future is in our hands. If we give a good base then in the future they are going to be good’ [Hala-PS1].

There was a sense of mission-driven purpose of transformation through education which was an explicit part of their school culture led by seniors and reinforced through training which emphasised, ‘All students are equal and we have to make a positive change for them’ [Shazia-A].

Teachers described their role well beyond imparting knowledge, caring for the whole child and doing ‘*tarbiyat’* (a difficult word to translate but relates to spiritual development of children’s affective nature: nurturing; developing character, teaching morals, etiquette and manners). This likely emanated from the lived experience shared by the students and teachers. Headteacher-A noted teachers were ‘devoted and they care because they share the same background as the children’. In school-B many teachers had attended the same school as their students.

Acknowledging parental limitations, particularly uneducated parents, Amna-A felt the purpose of their school should be to teach exactly ‘these kinds of children’:

> ‘We need to help children to survive beyond their circumstances, give them *taleem* (education) and *tarbiyat*. We have to help them learn and give them confidence, make them an expert in the subject…Our real purpose is to teach those whose parents are illiterate so that they in turn can support their parents’.

Headteacher-A emphasised the urgency of this over academic outcomes:

> ‘We have to do *pervarish* (nurturing, upbringing) of children. What parents don’t do we have to do. Teaching is giving something to children now. Knowledge can come later but we have to do *tarbiyat* now’.

Huda-A conveyed parents' own recognition of their limitation and perhaps their desperation, placing 'full responsibility of students' education with us, telling us that we cannot do anything with them. You are all they have. Whatever you do is what they will have'.

The teachers were cognisant of this responsibility. Shazia-A described what this meant practically:

> 'We teach them everything, handwashing before dinner, sharing your food, sitting in one place and eating. We focus on *tarbiyat* and we encourage them [parents] to do the same thing at home…We can't force children – they may have been beaten at home – so we have to travel with them'.

Headteacher-B articulated this in wider philosophical terms,

> 'My today has to be better than my yesterday…we cultivate '*rawaiya'* (attitude/conduct). As children leave and start their practical lives, we have to teach them how to think and how to feel. We have to stop extremism. We have to teach them awareness…truth …integrity…and earning an honest wage.'

4.4.5 Summary

Nighat-A's articulation of her role, holistically linking students' learning-outcomes to her practice, is a powerful summary of teachers' values based on their knowledge of the purpose and goals of education and their knowledge of their particular students,

> 'Teaching is like a father…you have to do *roohani* (spiritual), *deeni* (religious), *zehni* (intellectual), *mashriqi* (eastern) and *maghribii* (western) education. We have to teach children how to live. If I get a child to a good standard then nothing better, if a child does not learn then everything I am is useless.'

While teachers in both school conveyed a similarly mission-driven approach to their roles, they diverged markedly in their instructional practices, which I present next.

4.5 The instructional practices teachers use to teach mathematics

In this section I present findings in relation to my third research sub-question, RQ3, the instructional practices teachers use to teach mathematics, by articulating the structure and form mathematics teaching has in LCPS-schools. This is underpinned by teachers' knowledge of students discussed above and their knowledge of content, curriculum and pedagogy (general and content).

My findings are structured according to the components (RQ3.1 to RQ3.4) and themes (1a to 4c) within each component in my theoretical framework (Figure 2.1 on page 64).

I begin by presenting teachers' approach to lesson planning and preparation (RQ3.1). Then I articulate the classroom environment created by teachers including how behaviour for learning was cultivated (RQ3.2). Next, I present teachers' instructional practices (RQ3.3) followed by students' independent practice and teachers' use of summative assessment (RQ3.4). I deal with component RQ3.5 in section 4.6 under institutional environment which cultivates teachers as professionals.

Where relevant, as described in the methodology chapter (page 92), I differentiate between expert and novice practice using the descriptors derived from the literature review (see Appendix 5). Rather than two expert-novice extremes in my descriptors, my findings show there was an expert-novice continuum in teachers' practice: some teachers consistently exhibited all the features of expert or novice practice; others had expert practice with elements of novice practice and vice versa. Therefore, in my reporting, I use the following terminology to define practice: expert; expert/novice; novice/expert; and novice, as appropriate.

4.5.1 Approach to lesson planning and preparation

Teachers noted the importance of planning with three themes emerging: first developing content (1a) and curriculum knowledge (1b); second how this informed their lesson planning; and finally linking planning to their knowledge of students. I expand on each of these three themes below.

To reiterate the context of this study, teachers in both schools were young, inexperienced and unqualified, therefore, unskilled in teaching mathematics. The support and guidance provided by the school determined the extent of teachers' content knowledge and their approach to planning, particularly whether they were expected to cover the set curriculum or whether they adapted it in response to their students' needs.

4.5.1.1 Knowledge of content and curriculum

Teachers in schools A and B emphasised the relevance and prevalence of mathematics but differed on its perceived difficulty. 'Mathematics relates to everyday life. It is in everything. It is in life' [Amna-A]. School-A teachers reported they enjoyed teaching it as 'children learn quickly' and 'while students struggle with writing they get mathematics concepts easily'. In contrast, school-B teachers felt that mathematics was more difficult in comparison to other subjects, 'It's tough…it's hard but if we concentrate we can learn' [Hajra-B]. This variance in views likely reflects the variability in guidance provided to teachers, which I discuss here.

In both schools lesson planning was linked to teachers' content knowledge. Headteacher-B noted that first she had focused on the children but had realised that she 'needed to focus on the teachers – if they are learning, children will learn.' Amna-A explained that the chain assessed teachers' content knowledge; low-scoring teachers, supported by peers, then studied to improve their scores. However, the two schools differed in the support provided to teachers to gain content and curriculum knowledge.

School-A used the chain's bespoke mathematics curriculum supported by detailed teacher-guides and student-workbooks, which served as indirect training on content, general pedagogy and PCK. The teacher-guides comprise lesson plans articulating key mathematical concepts, teaching and assessment points, the rationale for the activities and resource suggestions. Teachers, aware of the importance of content knowledge, acknowledged their own position as learners of mathematics at the same time or just ahead of their students. They were unanimous in their praise of the detailed explanations in

the teacher-guides stating this meant ‘We don’t just learn the formula, we understand how to get the formula’ [Huda-A].

These teacher-guides were designed by an expert curriculum team at headquarters in response to teachers’ knowledge gap. To exemplify the level of detail, two lesson plans were covered in eight pages, providing opportunity for teachers to learn what they had to teach. In contrast, school-B’s syllabus was designed by the headteacher and comprised two pages covering the entire academic year, one for each of the terms. Each page consisted of the topic name and textbook page number. Occasionally there was a little more detail, such as for class KG1, ‘Learn 1 – 7 in words’ and ‘Six = 6 000000’. However, this seemed insufficient in supporting inexperienced teachers to gain conceptual understanding and teach it.

The two schools had differing approaches as to how rigidly the curriculum was expected to be followed. School-A teachers worked out ‘what to teach today and what to teach tomorrow and which order of activities will be better’ [Shazia-A]. Whereas, school-B teachers were expected to follow the set syllabus closely. Asma-B, the senior teacher, explained that a good teacher is one who ‘covers all the work in the syllabus’, perhaps not appreciating this may be at the expense of student understanding.

School-A teachers noted that although the teacher-guides had too many activities within a lesson, they felt confident in adapting them as they saw fit, staying on the same topic for longer or missing out others [Yasmin-A, Huda-A, Amna-A]. School-B teachers articulated the converse problem of children not having enough work to do within lessons. Describing her typical lesson, Aisha-B noted, ‘Children in mathematics do the work before I finish. So, I ask them to put their head down or they can work on another subject’. As a teacher with novice practices, she was not able to find other ways to use lesson time.

4.5.1.2 Lesson planning and preparation

Teachers across the schools were expected to have some sort of teaching schedule or planner. Like school-A, in pilot-school-3 teachers were expected to

> ‘maintain a lesson diary where they write down basic objectives and they write down the basic lesson: what they are going to do, page numbers from the exercise book, the course books and how they are going to assess it’. [Qudsia-PS3]

Expert aspects emphasised the relationship of planning to understanding:

> ‘It [planning] has to be good…first we have to understand, if we don’t understand how can we expect students to understand? Then we have to think how children will learn this, through lecturing, through writing?’ [Focus group].

Some teachers were clear about the preparation needed to go into planning a lesson and felt teachers should ‘prepare lesson in advance…do research at home’ [Hajra-B].

Inexperienced teachers said they worked through the questions set for students as part of their planning, seeking help from others when they needed it. This preparation suggests expert practice, however, given these teachers were studying basic mathematics, it implies limited propositional knowledge.

Expert practice involved using planning to consider wider aspects such as classroom management. A teacher in a pilot-school had written questions in students’ books in advance for them to work in class.

> ‘If I did that [wrote the questions in students’ books] in class the children would have been noisy. My attention would have been in the copies – that I had to prepare them – and it wouldn't have been on the children’ [Hala-PS1].

Teachers with expert practice, such as Amna-A, planned lesson and reflected on them on a daily basis. She felt this was important ‘learning for the teacher and learning for the student’.

4.5.1.3 Knowledge of students

Teachers in all schools linked their planning to their knowledge of students: ‘No one is perfect, everyone needs consolidation’ [Huda-A]. School-A teachers were

more precise than school-B teachers in defining the areas students experienced difficulties in such as ‘fractions, algebra, equations and geometry’ [Amna-A].

In all schools, teachers planned the same work for their students but they had a sense of which students needed additional support and used a range of strategies to address this. Shazia-A explained, ‘I can tell you which five children will not get it and then I have to work with them, give extra questions and stand with them when they are doing it’. Hajra-B explained that she plans her lessons by studying the topic first and ‘thinks who will get it. You can tell by looking at student they don’t get it. I will then ask them a question. Half will understand, half will not, so I start off with easy questions and then get harder’. No school, including pilot-school, had strategies for supporting students who found mathematics easy.

Teachers in schools-A and B were also cognisant as to who may have missed previous work and paid special attention to them in their planning. In school-B, teachers would copy the missed work into the students’ exercise books to help them catch up.

In summary, teachers experienced variation in the guidance provided to them in what to teach and how to teach it. Given both schools had inexperienced teachers, school-A teachers benefited from detailed teacher-guides, systematically available to all which enabled them to learn the mathematics they needed to teach, whereas in school-B they had to rely on colleagues. Teachers also differed in the freedom they had on curriculum coverage: school-A teachers varied this according to their judgement but in school-B there was a stricter adherence to coverage which appeared delinked from student understanding.

Next, I reflect on the classroom environment teachers create before presenting how the curriculum and planning translates into classroom instructional practice.

4.5.2 Creating a positive classroom environment

As discussed in section 4.4.4, a strong ethic of care (2a) emerged from teachers in both schools based on the importance they attached to developing

affective relationships (2b). This informed the classroom environment they created. Students' behaviour for learning (2c) appeared to be good in both schools, impeccable in school-A with classroom rules and routines well-understood (2d) by all. I expand on these aspects next.

When students joined the schools, they, and their parents, had to be socialised into the school environment. Many teachers reported that initially out-of-school children did not know how to behave or how to sit; that they would arrive at school dirty, unprepared and not know how to manage within the social environment of a school. Therefore, the norms and etiquettes of a classroom environment, the rules, routines and rituals, had to be taught by teachers and explained to the parents.

School-A trained teachers in how to use language, how to talk in front of students and how to support them to talk to each other enabling expert practice to develop. Teachers spoke to students in a very respectful way and promoted formal Urdu speech:

> 'We correct bad behaviour there and then, and we correct language there and then. We get really happy when they remember what we have taught them and correct each other' [Aliya-A].

Although there was variation across the schools, generally there was a positive classroom environment in the lessons I observed. In school-A it was exemplary. Children were incredibly polite, courteous and well-behaved. Lessons were characterised by a relaxed, purposeful environment with incidences of misbehaviour remarkable in their rarity (I observed only one minor incident in the week I was there). Teachers appreciated that children may be fearful or lack confidence, 'We have to help build it up' [Amna-A]. Teachers with expert practice exercised diminishing control and shared their space with students, frequently asking them to lead parts of the lesson. Expert practice skilfully managed behaviour, nuancing approaches depending on students and the situation:

> ‘I will be frank with children, sometimes you have to be personal with them to understand their problems. For older children I am not too friendly. They know what I want. They understand the direction from my eyes’ [Huda-A].

In expert practice, exemplified by Amna-A and Huda-A, expectations of conduct were so clearly understood that regardless of what the teacher was asking, the class appeared to know how to respond. Instructions were quietly given and acted on immediately, in an apparently unfearful way. Children would confidently ask questions, state if they did not understand and appeared to not be concerned about getting things wrong as lesson excerpts 4, 5 and 16 below exemplify. In the vast majority of school-A lessons, it was rare to see students off task for long. In the lessons with expert practice, this never happened. Expert/novice practice required more explicit behaviour management, employing a range of strategies including calls to attention such as clapping or counting to three, group competitions and rewards.

Novice practice, mostly found in younger school-B classes, was evident when teachers had fewer strategies for managing behaviour. They had to direct the class more often and were less successful in achieving their desired responses. Novice practice included shouting at children for talking, repeating instructions such as ‘be silent’ without it being acted on; and not following up when instructions were disregarded. Novice practice appeared to result from a combination of inexperienced teachers, little training and children having too little to do. For example, Sumera-B, a 16-year-old who had been teaching for only two weeks, was responsible for 25 infants and struggling to maintain their attention she eventually resorted to shouting.

Teachers across the schools were always fully active and alert in lessons, interacting with children and moving around the room. However, in school-A they experimented with a wider range of strategies to create a conducive learning environment. For example, Shazia-A told me she had researched ideas on the internet on managing behaviour which she had used in the lesson I observed. When students became too noisy she asked, ‘What do I want?’ The class all responded with fingers on their lips saying ‘mmm…mmm…mmm’ and quietened. When the lesson ended and students did not immediately pack

away, she said, ‘Look at my face, is it happy or sad?’ The class responded chorally ‘sad’ and began packing.

Senior teachers in school-B stated there was a no-hitting policy as this confuses and intimidates children and that ‘we have to handle with *pyaar* (affection/love)’ [Tasleem-B]. However, during two assemblies I observed teachers standing at the front of their class line giving younger students a gentle smack on their hands. When I asked a teacher what they were doing, she explained they checked the students’ nails and hair to see if these were clean or not.

School-A’s positive classroom environment appeared to be a result of a systematic approach. The headteacher said if potential for misbehaviour existed in classes she assigned teachers more adept at managing it. She also conducted weekly demo-lessons, at teachers’ request or as a result of her own assessment of need. Excerpt 1 is from a demo-lesson on behaviour management. Expert practice was evident in headteacher-A’s manner. She was gentle but firm, persisting until she achieved the behaviours she wanted from students. Ignored and unnurtured, children’s behaviour would likely remain as was evident here: students calling out, no team work and no sharing. In the post-lesson discussion, headteacher-A noted students ‘do not know how to share and care which is a school value’ and discussed several ways she would support the teacher in addressing this.

Excerpt 1 – Headteacher-A, Class 1 Demo-lesson on behaviour

Headteacher-A starts the lesson speaking very softly, requesting permission to take the lesson, which is granted with seriousness by the class.

Headteacher-A: If you have a question what you do?

Class [choral]: We put our hands up.

Headteacher-A: If I clap twice what do you do?

Class [choral]: We clap three times.

Headteacher-A: What is three?

Class shouts out.

Headteacher-A: What are we supposed to do?

Class shouts out more or less in unison: Put our hands up.

The children then put their hands up and Headteacher-A selects one who shows three fingers.

Headteacher-A: What is five?

Class shouts out.

Headteacher-A: What are we supposed to do?

Class put their hands up.

Headteacher-A: What is three?

Class shouts out.

Headteacher-A stops and claps twice. The class responds with three claps.

Headteacher-A gently reprimands them: What are we supposed to do? We are supposed to put our hands up. I am going to write on the board and I want hands up.

Headteacher-A draws 10 dots on the board: What is this?

Class puts their hands up and headteacher-A selects a girl to respond.

In summary, students, particularly those out-of-school, had to be socialised into school norm which teachers appear to have done successfully given the generally positive classroom environment I observed. In school-A teachers benefited from a systematic approach to managing behaviour, including training and in-class support, and a culture of testing out new strategies which made them more expert in this aspect. In contrast, more of school-B's teachers were at the novice stage. They had little systematic support and, therefore, struggled more in creating a classroom environment that was conducive to learning.

Next, I turn to how teachers structured their instruction in mathematics lessons.

4.5.3 Establishing effective instructional practices

In this section I present findings from the mathematics lesson observations in the pilot and in-depth case-study schools. I use the 'structure and form' section of the theoretical framework (Page 64) and analyse component RQ3.3 according to its themes 3a to 3i. These themes were difficult to disaggregate as they are interwoven elements of teachers' instructional practice. I had to make a decision on how to present them in a way that made the most sense: I begin by reporting on teachers' practices that focus on communication (3a). However, aspects of communication feature across all the themes of instructional practices. Next, I present how teachers framed lessons (3b) followed by how they provided direct instruction (3c). I separate this aspect into three themes: how teachers developed conceptual understanding (3f); scaffolded learning (3c); and guided students' practice (3c) by dealing with their errors (3i). Finally, I turn to how teachers used formative assessment (3d) and questioning (3e).

4.5.3.1 Communication

Expert practice was exemplified by an explicit development of students' mathematical vocabulary in Urdu and English, making connections between languages, prior learning and mathematical topics. Expert practice created opportunities for students to engage in mathematical talk, articulate their reasoning and provide explanations to the class. In contrast, novice/expert practice involved questions that elicited confirmatory single-word responses with novice practice exemplified by little mathematical communication and no questioning.

As the many excerpts below show (excerpt 2, 3, 5, 15, 16 and 19) it was school-A where expert practice was most often located. Through every part of the lesson these teachers modelled mathematical language, emphasised vocabulary and expected students to use advanced terminology, in Urdu and English. Huda-A explained:

> 'English is emphasised so much in other schools but then children end up not being able to do English or Urdu. English is needed. It is important. But when

you focus on quality education you have to know Urdu, so here we teach Urdu and English'.

Expert practice provided many opportunities for students to give extended answers and for student-to-student dialogue. Children were taught and knew Urdu as well as English definitions for words such as co-prime, factorisation and commutative as exemplified in excerpt 2. My mathematics teaching experience in England suggests this is unusual knowledge for 10-year-olds, even more so given that English is not their national language.

Excerpt 2 – Huda-A, Class 5 Developing mathematical vocabulary

Underpinned by her excellent subject knowledge (scoring 94% in the chain's teacher tests), Huda-A's lesson integrates previously learnt vocabulary into her explanation.

She asks the class questions such as whether one is a composite or a prime number. When a student answers 'it's a co-prime', Huda-A takes a side-turn revising definitions of prime, co-prime and composite before returning to the worked example.

Novice/expert practice, mostly in school-B, made much more use of repetition without probing understanding, for example, chanting numbers in chorus (excerpt 7) or asking questions that elicited single word, low-level knowledge recall answers (excerpt 8). At the extreme end of the expert-novice continuum, novice practice involved virtually no mathematical communication in the lesson (excerpt 10).

4.5.3.2 Lesson framing

Expert practice involved starting lessons by reviewing past work, checking understanding of work students did independently and orienting the upcoming lesson by rehearsing key vocabulary. Novice practice involved launching directly into instruction.

Lessons across all schools began with teachers writing the date on the blackboard and the number of children who should be present and are. School-B teachers wrote the subject while school-A teachers oriented the lesson by writing, in Urdu and English, the topic before reviewing the previous lesson. Excerpt 3 shows a typical expert orientation session with a strong focus on mathematical vocabulary.

Excerpt 3 – Shazia-A, Class 2 Orientation: Emphasising vocabulary

Shazia: What are we studying?

Class: Dharab ki ibarat

Shazia: What is dharab?

Class: Multiplication

Shazia: What is ibarat?

Class: Equation

Shazia: How do you spell it?

Class [choral]: E-q-u-a-t-i-on

Excerpt 4 exemplifies expert practice in using the orientation phase to review previous learning, address errors and provide space for student modelling. This enabled over-learning by the rest of the class without tedious repetition. It is interesting because it shows Huda-A's confidence in adapting her lesson to respond to previous work, pacing it in line with students' level and highlights students' confidence in airing their confusion.

Excerpt 4 – Huda-A, Class 4 Orientation: Reviewing homework, correcting errors

Huda-A asks if there had been any problems with the homework on lowest common multiples (LCM). Six children signal difficulty in calculating the LCM of 25, 40 and 50. Huda-A invites a boy who had said the answer was 300 to the front, asking him to recite the multiples of each number. After he does, she asks, 'So is 300 the right answer?' He responds, 'I still do not understand'.

Huda-A asks him to write the multiples on the board. Next, they work through the multiples for each number together circling the common multiples and identifying the lowest one. The student concludes that he now understands.

4.5.3.3 Direct instruction: developing conceptual understanding

Expert practice explicitly developed students' conceptual understanding through engaging, meaning-making instruction and maximised lesson time for mathematical instruction. Novice practice involved substantial amount of time on activities that had little mathematical value with students being taught facts and processes in rote fashion.

Expert practitioners exhibited a sense of pride that their students were not '*ratta*-masters' (rote learners) [Huda-A, Amna-A, Shazia-A] with school-A teachers explicitly noting the 'effort the teachers put on understanding and comprehension' [Nighat-A]. In contrast, novice practice, seen more regularly in the younger classes in school-B, involved transmissive instructional practices, teaching unconnected facts through drilling. Teacher with novice practices, many straight out of secondary school, restricted by their limited teaching repertoire, were unskilled in meaning-making instruction, having had little opportunity to learn the complex craft of teaching.

Exemplified in excerpt 5, expert practice involved making use of any available resources (buttons, straws and counters purchased with personal funds) to aid children's conceptual understanding, taking it from concrete to abstract. In this excerpt, Amna-A's questioning elicited single-word answers as her scaffolding

developed students' conceptual understanding of place value in a staged fashion.

Excerpt 5 – Amna-A, Class 1 Developing conceptual understanding of place value

Amna-A holds out one ice-lolly stick: This is a single stick. It is alone and has no friends.

Amna-A with the class then count to nine: Aik ikai, do ikai, teen ikai… (One ones, two ones, three ones…).

When Amna-A gets to 10: How do I write Dihai (ten)?

Amna-A writes 01: Is this right?

Class: No

Amna-A writes 10

Class: Yes

Amna-A: 10 is not alone. It has a friend, the ikai.

Amna-A counts ten sticks and bundles them with an elastic band. Next she hands out sticks and rubber bands to groups: I want you to make ikais and dihais and tell me how many you have.

After five minutes she pulls everyone together and models the language she wants used, showing her bundle: I have one dihai, and seven ikai, I have 17.

When a group shows 21, Amna-A asks: How many is this?

A student: Thirty

Amna-A stops the class and discusses this, unbundling the two tens and counting from one, getting the student to arrive at the correct answer.

In contrast excerpts 6 and 7 shows novice practice for a similar topic. Facts were rehearsed in a rote manner with little attempt at developing understanding of the number under study. This was typical practice in school-B and the pilot-schools. Excerpt 7 from a different lesson on number had limited direct instruction. The class chanted the numbers and then copied them into their books.

Excerpt 6 – Suman-B, KG1 Copying numbers

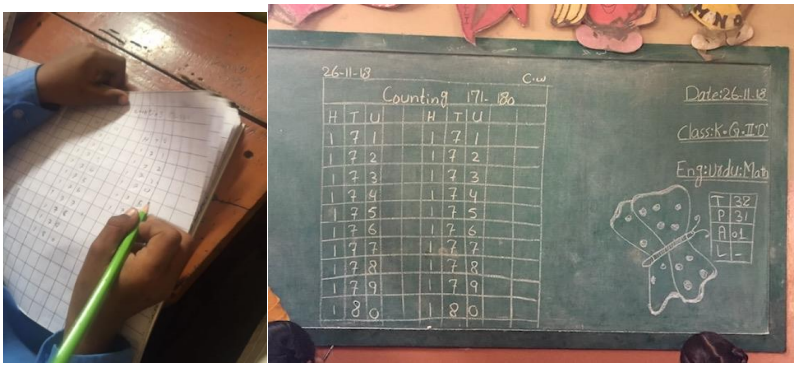
After asking the class to trace '29' in their workbooks, Suman-B marks about eight pages of homework and classwork, spending about a minute per child.

While she does this, I ask a student, pointing to 29, what it is. He replies, 'two' and 'nine'. Another boy counts to 10 but is not able to go further. Another tells me how far each student on the table can count…one to ten, another to 20 and he himself to 100. He proceeds to show me but after 15 began counting incorrectly '15…19….26….29'.

Due to the demands of covering the syllabus, which for this lesson was '29', students were drilled on numbers with inexperienced teachers unable to question whether this was the right thing to teach given students' limited prior knowledge. As teacher with novice practices, they were unskilled in assessing if students conceptually understood or not.

Excerpt 7 – Sara-B, KG2 Copying numbers

Sara-B draws a table and writes the numbers 171 to 180, (see photo) which students copy. Then together they loudly chant each number, repeatedly.



Sara-B then marks students' books, taking around 30 minutes, while they wait.

After the lesson, I ask Sara-B what the children had learnt. She responds, 'We have practiced a lot and so they all know'. When I ask how she knows they know, she replies, 'They know. Everyone knows'.

Rather than direct instruction, novice practice involved substantial amount of lesson time taken up in non-mathematical tasks (excerpts 6 to 8). This predominantly involved teachers either asking students to copy from the board for extended periods of time (novice) or setting students five to six questions to do and then spending the majority of the lesson marking these (novice/expert). For example, over 60% of the lesson, in one case for the whole lesson, children sat quietly with nothing to do except wait for teachers to finish marking. Novice practice involved no student-teacher discussion during these marking episodes nor an attempt at developing or checking understanding whereas novice/expert practice involved some discussion and correction.

Two lessons, both teaching number to the same year group, highlight the different instructional practices on the expert-novice continuum: one demonstrating novice/expert practice (excerpt 8a and 8b from school-B) and the other expert practice (excerpt 9 from school-A).

Excerpt 8a shows Salma-B using word problems and providing direct instruction through modelling the calculation process interactively engaging students (expert elements). Elements of novice practice include nearly 40% of the lesson spent on students copying questions; transmissive teaching without attempt at developing conceptual understanding; low-level recall questioning; and not assessing or rehearsing the prerequisite knowledge related to the topic such as whether children could do column addition before setting word-problems requiring this skill. For example, in this lesson a student tackled column addition from the left rather than the right.

Excerpt 8a – Salma-B, Class 2 Worded problems through instrumental learning

Salma-B writes on the board a question that is in the students' textbooks and asks them to copy it into their books.

> Saima has 151 stamps. She collects 109 more. How many stamps does she have altogether?

For the next 15 minutes Salma-B checks it has been copied correctly. She tells a girl that her writing is too big and asks her to rewrite it. Salma-B then works through the example, answering her own questions, then returns to checking children's writing.

151	+	Salma: One plus nine is ten. Can I write the whole of ten?
109		No! I have to carry it over.

Salma-B repeats with another question. This time a girl had written the second question below the first one. Salma-B asks her to rewrite on a new page.

Salma-B works through the problem, this time shouting out questions to students who in turn shout back the answers, struggling to get themselves heard due to the noise from surrounding classes.

345	-	Salma: Five subtract four
54		Class: One
291		Teacher: Four subtract five? Borrow from left hand column
		Class: Fourteen
		Teacher: Fourteen subtract five
		Class: Nine
		Teacher [pointing to the 3]: what is left here?
		Class: Two
		Teacher: Two take away nothing
		Class: Two

Most students appear to know what to do and the drilling helps.

Excerpt 8b highlights another student using their own strategy for doing mathematical calculations. As the point of formal methods such as column addition is efficiency, this suggest novice practice in not identifying and

discussing different approaches to calculations, including mental calculations given the student was not wrong in his approach, merely inefficient.

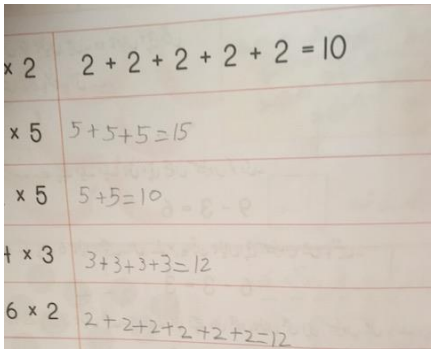
Excerpt 8b – Salma, Class 2 Children develop their own strategies

438	+	Instead of borrowing and carrying a student works out 8+6=14 and writes this down. Then he rubs out the 1 and adds it to the units column. This is a long strategy for this supposedly efficient method.
246		
14		
438	+	
$24_{1}6$		
4		

Excerpt 9 shows a typical expert approach to teaching multiplication through a commitment to engaging, meaning-making instruction. It emphasises the development of conceptual understanding by connecting multiplication to repeated addition, moving students' understanding from concrete to abstract representation through the use of resources. The activity reinforced students' understanding of what multiplication is and how it links to addition. This was further consolidated through linked exercises in student-workbooks, which connected the concrete physical representation using ice-lolly sticks with the more abstract concept in the workbooks.

Excerpt 9 – Shazia-A, class 2 Developing conceptual understanding of multiplication

Group work showing student understanding of what 5×4 represents.



In contrast, novice practice in teaching the same multiplication topic is seen in excerpt 10. It is exemplified by rote learning with, in this case, no instruction during the lesson. The same lesson was then repeated to three other classes by Abira-B.

Excerpt 10 – Abira-B, Class 3 Learning multiplication

Abira-B spends the full lesson marking students' homework, which was to write the 13 and 14 times-table, by asking two girls at the front to read out the answers to her.

4.5.3.4 Direct instruction: scaffolding learning

Expert practice involved scaffolding learning in lessons and over a series of interconnected lessons bringing students to the point of undertaking complex, multi-step problems that could be solved in different ways. Teachers with expert practice exhibited a problem-solving view of mathematics and modelled this whereas novice practitioners taught students in rigid, ritualistic ways.

As exemplified in excerpt 11, expert practice involved careful scaffolding over several lessons and precise modelling as well as reinforcement of instruction. This resulted in students equipped to handle the complex cognitive demands made of them. The classroom atmosphere created by teachers with expert practice, combined with well-thought out activities requiring discussion, meant it was likely students regularly went beyond their individual zone of proximal development.

Excerpt 11 – Huda-A, Class 5 Academically challenging activities

Having learnt how to work out the highest common factor (HCF) of simple numbers using the tree-method and tabular division over past lessons, Huda-A explains to students she is going to teach them a 'fool-proof' efficient way. The task is to work out the HCF of 27, 36, 72 and 144. She constructs the table below.

3	**27**	**36**	**72**	**144**
3	9	12	24	48
3	3	4	8	16
2	1	4	8	16
2	1	2	4	8
2	1	1	2	4
2	1	1	1	2
2	1	1	1	1

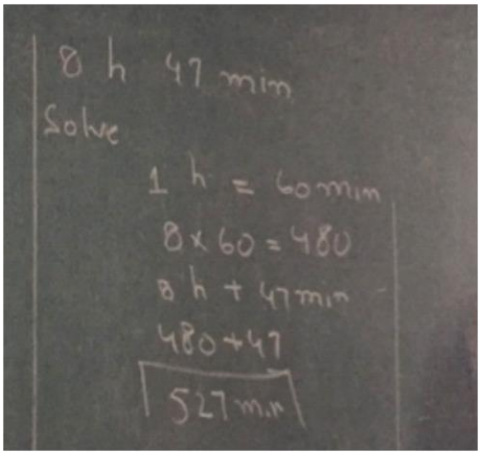
The representation is demanding requiring several mathematical skills concurrently. Huda-A models interactively, constantly making links to other areas of mathematics, having a to and fro with the class. She emphasises working systematically, showing working out and recording diligently, all key mathematical skills. Huda-A then discusses with students the many different ways of calculating the HCF mentally, which is the multiples of the first column.

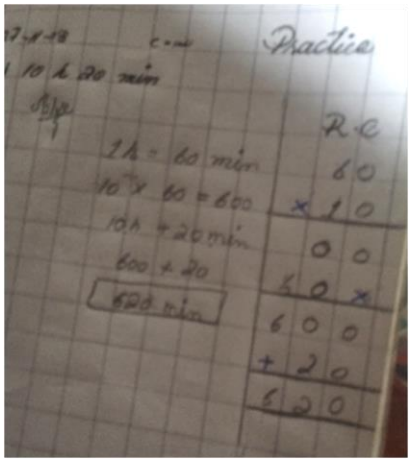
She asks another student to go over the method, taking on a facilitating role and demanding choral responses from students, before setting the class questions for seat-work. Huda-A adds a little pressure saying, 'I will call anyone to the board so you all need to be prepared to answer'.

Huda-A's expert emphasis on mental calculation for complex mathematics sits in contrast to Sadia-B's novice practice (excerpt 12). Her lack of focus on this meant her students used long multiplication to work out simple questions involving multiplying by 10.

Excerpt 12 – Sadia-B, Class 4 Lack of challenge for mental calculation

Sadia-B begins the lesson by explaining and modelling how to convert 8 hours 47 minutes into minutes (see photo below).





She then sets problems for the class to do. As there is no expectation to use efficient mental calculations, students inefficiently and in this case inaccurately use long multiplication to work out 60×10.

Excerpt 12 highlights the expert-novice continuum. While novice in the use of mental calculation, elements of expert practice includes setting cognitively demanding mathematics problems and modelling the process for solving these. This excerpt shows for older students in school-B the cognitive demands in mathematics lessons increased with more evidence of expert practice: more direct instruction, less time on non-mathematical activities and greater modelling of problem-solving approaches. Headteacher-B had said as young teachers gained experience she moved them to older classes which may explain this.

Another example of expert-novice continuum is seen in excerpt 13. Expert element was in developing conceptual understanding through visual representation of multiplication; novice element was the lack of systematic representation which prevented students visualising how 20 connects to five lots of four to 5×4.

Excerpt 13 – Nighat-A, Class 4 Examples of weaker mathematical modelling

Nighat-A, in a lesson on multiplication, writes 5×4=20 on the board and draws 20 stars in a random fashion. When Nighat-A went to mark students' responses to the set questions, she had to count each star as students also did not present answers systematically.

4.5.3.5 Direct instruction: guided practice and dealing with errors

While all teachers engaged actively throughout the lessons, there were differences in expert and novice approaches to guided practice and seatwork. Expert practice involved setting tasks in guided practice that were cognitively demanding and interesting whereas novice practice involved setting less demanding questions. Expert practice was exemplified by using this time to identify errors and address common ones by stopping seatwork and providing teaching inputs to the class, creating opportunities for whole class rehearsal and consolidation. Novice practice involved marking and correcting individual student errors.

In every lesson while students were engaged in seatwork teachers walked around the class, checking work and correcting errors, providing explanations where necessary. Shazia-A explained, 'I feel I have to check there and then'. A pilot-school teacher explained why engaging with the class in guided practice was important:

> 'There are some children that you have to stand on their heads to make them work. While we are standing there they will write, if we move away this stops...So we have to look at them with full concentration' [Hala-PS1].

Expert practice during guided practice involved providing students with open-ended, complex tasks that had multiple approaches to be tried and discussed, even in younger years (excerpt 14 and 18). This facilitated opportunities for group work during which student-to-student mathematical discussion took place. Teachers with expert practice planned explicit opportunities to show that mathematics can also be about trial-and-error as opposed to single-method, single-solution fixed subject by utilising activities to promote students' active

participation (excerpts 11, 14 and 18). These created opportunities to unearth and address students' misconceptions and errors. The class' focus and perseverance on tackling these complex problem was impressive, given their young age.

Excerpt 14 – Yasmeen-A, Class 1 Open ended task

Yasmeen-A asks the class to create their own subtraction sums. Despite the fact her earlier modelling had been of single digits, during seatwork children write a variety of sums such as 50-25, 200-100 and even 1000-500 making correct use of the '=' sign.

Expert practice appears to have four aspects when dealing with errors: identification by teachers and students; student-to-student correction (both seen in excerpts 15, 16 and 19); challenging basic errors (excerpt 17); and seeing errors as an integral part of doing mathematics (excerpt 18 and 19).

Expert practice created a culture of identifying errors and sharing responsibility with students in addressing these. A teacher articulated school-A's ethos,

> 'If children say they cannot do something we have to encourage them to try. We have to expect and accept wrong answers and correct them, and use other students to help guide them' [Focus group].

Excerpt 15 – Yasmeen-A, Class 1 Identifying errors and facilitating student-led modelling

Yasmeen-A spots some students writing the units in the tens column and vice versa and stops the class. She invites a boy to the board to model the correct representation. He explains, counting out sticks in tens and units, arriving at 23, 'So there are two tens so I write 2 in the tens column, and there are three ones so I write 3 in the ones column'. Next Yasmeen-A asks him to explain the difference between 4 and 40. The class then continues the set task and this time with greater accuracy.

Expert practice involved teaching students to identify errors in their own and each other's work sensitively. The 'ethic of everybody' is exemplified in excerpt

16. The seriousness with which children sought to learn from each other was unusual in my experience.

Excerpt 16 – Amna-A, Class 2 Student-led explanations

Amna-A invites a boy to the board to correct a mistake he made writing 4×5=9. She asks what '×' means. When he is not able to answer she invites his friend to explain who says it means '4+4+4+4+4' and writes this on the board. When Amna-A asks for further explanation, he says, 'I added 4 five times because that is what 4×5 means'.

Amna-A then invites a girl to do this sum differently. She writes 5+5+5+5 and explained she added 5 four times. Another boy calls out that this is not right, Amna-A asks him why. He works it out, concluding it is right.

Amna-A turns to another girl and asks her to check. She adds slowly while the class patiently waits for her to finish. Some are mouthing the calculations to themselves but one boy is bursting to answer. Amna-A gently tells him, 'I want her to answer'.

However, not all errors are equal and expert practitioners exhibited the warm-demander, tough-love characteristics when they felt the errors were not of an acceptable nature (excerpt 17).

Excerpt 17 – Huda-A, Class 5 Challenging basic errors

Huda-A stops the class when she spots an error several students are making, writing 96 ÷ 2 = 58. She signals her disappointment at this, 'I have told you that in mathematics you can check your answers'. She invites a student to explain how to check. The student replies, 'double it'. When Huda-A asks her to do this on the board, the student makes the error of not carrying over.

```
 4 8   +
 4 8
-----
 8 16
```

Huda-A asks her to do it mentally and expresses her disappointment at this error repeating, 'You know this, you know this'.

Expert practice involved frequent interspersion of direct instruction with guided practice and vice versa as recommended in the school effectiveness literature. Teachers with expert practice did not hesitate to interrupt seat-work to discuss common errors. This led to an interactive classroom atmosphere rather than a pattern of teacher-led exposition preceding student seatwork evident in novice practice.

Excerpt 18 exemplifies how expert practice welcomed mistakes, seeing it as a process of mathematical problem-solving.

Excerpt 18 – Huda-A, Class 5 Rich multi-method problems

Huda-A sets a complex algebraic problem for students to solve using trial and error:

T + T + S + S = 14

S + S + T = 12

C + S + T = 10

She invites a girl to provide the correct solution asking her if she got it wrong first. The girl responds she had and had to try several times before getting it correct.

Expert practice involved making skilful links across pedagogical practices as seen in excerpt 19. By asking students to spot errors in a peer's work, Huda-A ensured the class' engagement by tapping into their competitive spirit and provided opportunities for further guided practice led by a student this time, enabling consolidation through rehearsal in an interesting way.

Excerpt 19 – Huda-A, Class 5 Seeking errors

Huda-A concludes her lesson by asking a student to show his worked example and invites the class to identify errors. The multi-steps rich problem presents numerous potential for errors so his peers concentrate.

The student starts writing on the board, twice other students put their hand up to say they have spotted an error. When Huda-A asks them to work through the 'error', they conclude it does not exist. Huda-A insists there is one and would lose him marks. Her big reveal is he has not shown the final answer.

The student is given a pencil sharpener as a reward 'for getting the answer wrong the first time and persevering until you got it right'. Huda-A then summarises the process but with greater speed. The students by now have had three substantial explanations of the same concept.

Expert practice was exemplified by alertness to key conceptual mistakes students may make; explicitly addressing these in a timely fashion, taking side-turns as needed; and emphasising mathematical presentation. Novice practitioners were less skilled in this as they had not built up the store of schemas that were evident in experienced teachers' practice so were not as able to respond to unexpected events in the classroom. Consequently, errors were either not identified (novice) or when spotted, were simply corrected without discussion or the unearthing of the conceptual misunderstanding that lay behind them (novice/expert).

4.5.3.6 Formative assessment and questioning

Expert practice with regards to formative assessment accompanied direct instruction, aiming to foster students' autonomy by teaching them to identify errors; training them to ask questions; and correct and learn from each other (excerpts 4, 15, 16 and 17). This was absent in novice practice.

Expert practice skilfully mixed procedural 'why' and 'how' questions with product 'what' questions. This provided teachers with many opportunities to assess student understanding and correct misconceptions in a timely fashion.

In contrast novice/expert practice was exemplified by questions that checked low-level factual recall without further questioning to understand the reasoning beneath the answers. Novice practitioners were not skilled enough to assess understanding so students' misconceptions remained latent (excerpt 6 and 8a). In these lessons students were passive respondents to the instructions they received. This did not relate to their engagement in lessons which was evident during direct instruction, rather it alludes to the limited opportunities they had to direct their learning due to the rigidly controlled structure of the lessons set by teachers with novice practice.

In summary, there are within- and across-school variations in teachers' instructional practices. These coalesce around the concentration of expert and novice practices. Expert practices were more dominant in school-A exemplified by: the intentional development of students' conceptual understanding utilising activities that included open-ended, multiple-solution mathematical task; questioning that demanded mathematical reasoning from students; and skilful identification and addressing of student errors and misconception. Expert practice provided multiple opportunities for: rehearsal of skills to master learning in engaging ways; students to learn from each other in groups and as a class; and students to develop efficient strategies for calculation, including mental arithmetic.

In contrast, teachers with novice practice (mostly in younger classes in school-B and in some school-A teachers who had a mixture of expert and novice practices) without any other recourse employed the pedagogy of the unskilled. They focused on covering the curriculum without having the skills to assess if students understood it; taught students rigid, single-approaches to mathematical calculations and problem-solving in rote fashion; employed passive pedagogies that placed low cognitive demand on students; and utilised lesson time for activities that had limited mathematical value.

In my observations school-A had several examples of consistently expert practice. Where teachers employed novice practices they also had aspects of expert practice, whereas in school-B novice practice was more consistent in

younger years. It was also more reflective of the pilot-school teachers' practices.

4.5.4 Independent practice and summative assessment

This is the final component of instructional practices. Both schools set homework (4a) and had a system for conducting summative assessments (4b). However, school-A had a systematic way of using this to address gaps in students' learning through remedial classes (4c).

Teachers in both case-study schools expressed frustration at the lack of independent practice done by students in their own time. Huda-A said, 'Children need to practise, practise makes perfect, but they don't'. Amna-A reflected that sometimes she gets angry when children do not do homework and 'we have to teach them again'. Nevertheless, it was apparent they had an understanding and an acceptance of how children's home lives interfered with their academic life. Several teachers noted that children lack academic support at home so they deliberately set undemanding homework.

There was an expectation from some teachers in the pilot-schools that parents should support their children with homework but this was seen as a joint school-home responsibility. When describing how she used homework to assess understanding, Hala-PS1 noted,

> 'Sometimes children will understand in the class but they won't understand it at home, then there is a 'lackness' somewhere, either in the parents or with us. So, we tell the parents and we also look at the child'.

Both schools had a formal assessment system; school-A's was integrated at a systemic level with support provided to address students' learning gaps. While school-B also conducted monthly tests with results reported to parents, individual teachers were expected to address areas of concern. Headteacher-B noted she oversaw the monthly papers and expected teachers to send a summary of who failed and how they will 'fix it'.

Headteacher-A explained teachers in school-A, informed by their formal assessment system, regularly discussed students' learning-outcomes with her.

As well as homework assignments, teachers set weekly assessments and monthly test papers. Twice a year, most classes had externally administered assessments, which teachers marked, and others moderated. Then a question level analysis identified each students' and class' strengths and areas for development which fed into teachers' training and the school's improvement plan. Six to seven lowest attaining children were then given remedial classes. Although this intruded into teachers' planning time, their focus on equity meant they valued this approach and proudly talked about the success students subsequently attained.

Headteacher-A appreciated the rigorous assessment system. Her school achieved highly compared to the chain's other schools, despite, the headteacher notes, her students being more deprived. She proudly stated, 'we have a name'.

In summary, both schools had formal assessment systems to check who was falling behind with the headteachers' overseeing the process. School-B expected the teachers to address students' gaps whereas in school-A there was a more systematic school-level approach.

4.5.5 Summary

Although informed by the same vision and expectation, the above signals markedly different pedagogies exemplified by the expert-novice continuum.

All the features of effective teaching found in HIC were evident in expert practice (located in school-A), including a focus on developing conceptual understanding, mathematical reasoning and problem-solving skills. Whereas in school-B teachers exhibited novice practices more consistently including: rote learning, lack of emphasis on conceptual development, inefficient methods taught to students and time spent on non-mathematical activities.

However, novice practice did not appear to be a result of teachers' apathy or lack of effort. It appeared they simply did not know what else to do and had limited access to resources, training or support to practise teaching differently. They delivered on the requirement to cover the syllabus and to mark books in

lessons. Therefore, rather than pedagogy of indifference they employed the pedagogy of the unskilled.

Next, I turn to the final component of the theoretical framework, teachers as professionals, to answer research sub-question, RQ4.

4.6 The institutional environment supporting/hindering the development of mathematics teaching

In this section I reflect on the institutional environment that resulted in the practices described above. This includes how teachers view themselves as professionals which I explore through three themes: teachers' professional character (5a); support for their professional development and continuous improvement (5b); and their relationships beyond the classroom (5c).

4.6.1 Teachers' professional character

Teachers across the schools described a good teacher using similar vocabulary. Themes that emerged were the concept of caring and loving (using words such as '*mohabbat*' and '*pyaar*'); the concept of nurturing, building character, teaching etiquettes and manners (using words such as '*tarbiyat'* and '*pervarish'*); the concept of building relationships with children based on kindness (using words such as friendly, likeable and patient); and the concept of being a role model (using words that conveyed how they themselves should behave). Teachers' sense of character was also evident in what they did, especially in the care and commitment they demonstrated towards their students.

Teachers' also articulated a professional aspect to teachers' character. This ranged from being on time, present and prepared to striving for improvement. Tasleem-B noted 'We learn when we teach, and when you can explain you learn more'. Several teachers reported how they were undertaking higher studies in their own time; researched teaching activities on the internet; and watched pedagogical videos. School-A teachers' set a high bar. Amna-A was embarrassed about her 'low' test score of 91% despite the pass mark being 60%. In addition, they conveyed a professional confidence that was missing in teachers from other schools. This was apparent in their ability to be

constructively critical about demands on them such as documenting actions which they felt were unproductive. In contrast, school-B teachers were not able to suggest any improvements their seniors could make.

4.6.2 Professional development and continuous improvement

Teachers across the schools were enthusiastic about training and all pilot-school teachers, including school-B, requested more. Most pilot-school teachers recalled DFID funded training on the 'child's mind and how we should teach them' [Rani-PS2]. They noted 'from training we will learn new things, get new ideas. We learn from training how we can become even better' [Rani-PS2].

The institutional environment for teachers' professional identity began at the recruitment stage which set the framework for teachers' drive for improvement. Huda-A observed the chain 'recruits *dilwale* (people with heart) and makes them *dimaghwale* (people with knowledge and skills)'. Headteacher-A concurred, 'We have to recruit passionate people because the demands of the school are very high'. There was a strong culture of improvement in school-A and an energy about teaching, which the headteacher appeared instrumental in establishing. She revealed through interviews how well she knew teachers personally, who was having financial difficulties, whose husband was ill, what demands were on their personal time. This care likely contributed to the evident camaraderie amongst the staff. At breaktime they sat together in the staffroom around one table, ate food they brought for each other and were friends outside school. Older teachers were shown respect, even though the younger teachers were the senior teachers. Headteacher-A was clear about her role as the 'leader of learning'. When observing teachers and giving feedback she established a collaborative approach rather than a blame culture. 'We will fix it together' she said she tells the teachers.

Teachers enjoyed teaching and learning about improving their teaching. Even when headhunted by others, 'teachers stay in the school because they learn more, because of the atmosphere, and because they are inspired by the vision and mission of the school' [Nighat-A].

The school-A headquarters' devised continuous improvement cycle informed training and was universally valued. Despite the rigorous and comprehensive evaluation system (lesson observation, book reviews, student test scores and annual teacher tests with results displayed in the headteacher's office) teachers were positive about it, feeling it contributed to the quality associated with the chain, proudly noting our 'checks and balances are tight' [Amna-A]. Several noted it enabled them to learn, to focus and to improve. Rather than an accountability burden, they saw the process as an endorsement and validation, a badge of honour to be part of the chain's team. The system appeared to put pressure on teachers in a constructive way. Headteacher-A noted its importance in facilitating discussions with teachers on learning-outcomes, 'Teachers felt bad if their children do badly'. Amna-A explained she had a student who could barely read, 'I was worried about what to do as it would affect my evaluation score'. Therefore, when planning her lessons, she focused on activities that would motivate him.

The accountability system was appreciated because it was matched with a support system, both in an informal way through the camaraderie of the staff and in the formal support structures. Headteacher-A paired lower scoring teachers with higher scoring ones to aid their planning and teaching. As well as annual headquarter-led training, there was monthly in-school training, with teachers training each other through micro-teaching sessions. The collegiality was evident in the requests teachers made of each other, including training on topics which helped to 'clear up concepts and vocabulary' [Shazia-A]. Subject teachers prepared practice tests for their colleagues. Teachers had a WhatsApp group with teachers from other chain schools and used it to share worksheets, answer sheets, examples of children's activities and videos of teaching episodes. A career progression route was available to teachers who had high evaluation scores: they could become regional and national trainers, overseeing subject teachers in their local cluster of schools.

School-B's improvement process was less systemic, more personal and dependent on the headteacher who clearly cared about her staff. She reported, 'Teachers have been taught by me…they are like my children'. Teachers valued

her highly noting she is ‘very nice’ and ‘we have learnt a lot from her’. They discussed problems with her noting, ‘she explains gently and corrects with *pyaar* (affection/love) so we try not to make the same mistake again’. Headteacher-B reported she devised exercises for teachers so they ‘learn before they can teach’. Once a month she delivered training on topics such as ‘how to guide children and how to write’ [Asma-B]. However, overseeing a staff of more than 26 teachers in the primary school alone, this level of support appeared insufficient.

While school-A’s senior teachers focused on pedagogy and had conversations about learning, the senior teachers in school-B saw their role as checking teachers, ‘how they are clearing the syllabus, their attendance and students’ attendance, and considering the problems of children such as homework, diaries and parents meetings’ [Asma-B]. The senior teachers, themselves young and inexperienced, were motivated but uninformed on how to support teachers as they were unexposed to concepts such as joint-planning and team-teaching.

4.6.3 Relationships beyond the classroom

Teachers in school-A, more so than school-B, recognised their role as beyond working with students to working with parents. ‘Parents, teachers and students have to work together’ [Huda-A]. They recognised that parents were appreciative of their work. ‘We are respected by the parents and they ask us for advice’ [Amna-A]. They had an open-door policy which I saw in action on several occasions. They also offered free adult literacy classes. ‘Parents want to learn so they can teach their children’ [Focus group]. School-B teachers appeared more frustrated with the challenges presented by parents stating parents blamed the teachers when their children did not learn. Some teachers were more sympathetic, noting they should support parents to be more ambitious for their children, ‘We have to raise their expectation beyond matriculation’ [Noor-B].

School-A was strategic in working with the government, providing advice to it on issues such as assessments and adopted government schools to transfer their school improvement processes, which teachers said they were proud of.

4.6.4 Summary

Teachers across all schools had a similar sense of teachers' professional character and described it in relation to personal attributes which they embodied and professional behaviours which included their improvement practices.

The institutional environment in both schools was caring and aimed to develop teachers' practice. In school-A this was comprehensive and systematic: teachers valued the approach perceiving it to be an endorsement of their work, providing support and external validation. In school-B it was more ad-hoc and dependent on the headteachers' ability to support a large teacher body.

With respect to relationships beyond the classroom, school-A's work with colleagues, parents and government influencing policies was strategic and systematic, whereas school-B's approach was limited to parents and mixed with frustration.

4.7 Conclusion

In both schools the recruitment practices result in teachers who often share the same background as the students and, therefore, understand the barriers they face and were motivated to address these. Teachers saw education as a route to transforming the lives of their students, families and the community and took personal pride in students' achievement.

In school-A a systematic process held teachers to account while supporting them to improve. The detailed teacher-guides developed their subject knowledge and pedagogical skills. This was enhanced by lesson observations, demo-lessons and training programme that responded to their particular needs. School-B teachers were very young, far less experienced and had fewer support structures to help them develop their teaching knowledge base.

Mathematics teaching was on an expert-novice continuum with expert practice concentrated in school-A and novice practice in school-B. Expert practice was exemplified by teachers skilled in developing students' conceptual understanding and addressing their errors and misconceptions in engaging ways. In contrast, novice practice emphasised covering the syllabus with brief

episodes of knowledge transmission and rehearsal, followed by extended amounts of time used by teachers for marking in lesson. This was also typical of the practice observed in the pilot-schools. However, in the older classes as teachers gained experience, instructional time increased and instructional practices become more expert.

Next, I explore why instructional practices were as they were.

Chapter 5 Discussion of findings

On embarking on this research my intention was to explore teaching and learning in mathematics in Karachi's LCPS. In doing so I had a bias toward exposing expert instructional practices in mathematics which led me to the selection of two in-depth case-study schools likely to exhibit expert practice. In reality, teachers in these two schools had very contrasting teaching and learning approaches. Through an in-depth study of the two schools, as well as the five pilot-schools, I was able to build a picture of teachers' novice and expert instructional practices utilising my theoretical framework, confirming relevance of the HIC effectiveness literature to Karachi's LCPS-schools.

5.1 Summary of findings

Three key findings emerge from the study of mathematics teaching and learning in LCPS-schools:

1. A very strong sense of moral purpose underpinned by a transformational view of education drives LCPS teachers' ethic of care.

2. Teachers exhibit a continuum of novice to expert mathematics teaching practices within- and across-schools; more consistently expert practice was evident in school-A and more consistently novice practice in school-B.

    a. Teachers of mathematics exhibiting expert teaching practices in Karachi's LCPS-school have the same components of instructional practices as found in teacher effectiveness literature in HIC.

    b. Inexperienced, unqualified, yet motivated teachers can be supported to enact expert practices through a systematic programme of ongoing professional development.

3. Given its scale and, therefore, relevance the LCPS is a sector that should be supported. It cannot be ignored.

In this chapter I summarise my findings in relation to the above three key findings and discuss the issues that arise.

Research from HIC shows that the most significant source of variance in students' cognitive and affective outcomes is their cognitive ability and their home background. The next largest factor is what teachers care about, know and do in the classroom (Hattie, 2003; Kyriakides & Creemers, 2009; Aslam & Kingdon, 2011). This aspect has even greater impact in L&MIC than HIC (Stoll & Fink, 1996; Hanushek & Woessmann, 2007). My findings show students in Karachi's poorest districts start school, whether LCPS or government, with similar learning-outcomes; these are related to their age, whether they had previously been in school and whether their family members had (page 106). The progress they make is then up to the teachers reflecting a parental view, 'You are all they have. Whatever you do is what they will have'. Parents' confidence in the teachers suggests that they practised culturally responsive teaching, gaining parents' and students' trust mediated through communication and knowledge about students (Bonner, 2014).

With regard to what teachers care about, know and do, of Shulman's (1986) seven teacher knowledge bases, LCPS teachers have powerful and broadly consistent knowledge of: educational goals, purposes and values; contexts; and students which informs what they care about. Teachers were consistent in their knowledge of students' characteristics but varied in their knowledge of students' cognitive understanding. This variation is linked to their differing knowledge of general pedagogy, content, curriculum and pedagogical content. It is this discrepancy in knowledge, as opposed to their values, which leads to the variation in their practice, ranging from novice to expert.

I discuss what teachers care about, key finding 1, in section 5.2 and what they know and do, key finding 2, in section 5.3 with section 5.4 focussing on the LCPS.

5.2 An ethic of care informing a transformational view of education

Teachers in the pilot and in-depth case-study schools have a strong moral purpose guiding their view of education, teaching and students who come from deprived backgrounds with parents in unstable occupations and likely to be illiterate with little experience of formal education. Despite this, parents invest a considerable amount of their limited income educating their children in the

LCPS, overlooking the nominally free government schools close to their residence. This lack of family educational background marginalises students from society and can lead to them experiencing cultural discontinuity in school (Knapp, et al., 1995). However, across the schools teachers articulate not just the academic but the affective aspect of their work to address this discontinuity.

Teachers in all schools had a strong ethic of care and a pervasive sense of being in loco parentis inspiring them to forge personal connections with students (Hargreaves, et al., 2017). This sometimes was to make up for missing parents but often to support parents who in the context of poverty or illiteracy were not able to do fully themselves: *tarbiyat* (nurturing, character development, teaching etiquettes and manners) and *pervarish* (upbringing). They educate students on the basics of how to be: to talk, to wash, to dress, to sit in lessons. Defined as soft skills these are not captured in donor results framework but are important in navigating different strata of society.

Given how frequently teachers across the schools described their efforts to socialise students into the school culture, the positive classroom environment and student behaviour indicated their success in doing so. Biased by my own English teaching experience, my field notes expressed surprise at the unusually positive behaviours and growth mindset attitudes students demonstrated in school-A and the patience with which students waited for their teachers in school-B (Dweck, 2006).

There was a reciprocity to the teacher-student relationship; teachers derived personal fulfilment and pride from the transformation they brought in their students, both affective and academic, feeling they had to do justice to students' efforts instead of labelling them (Zyngier, 2016). This picture contrasts with research suggesting some teachers have low expectations of the poor (Duflo, et al., 2011) or believe they are unteachable (Brinkmann, 2018). The LCPS teachers shared their students' background and this likely contributed the fuel for their drive to address through education the inequality children experience (Unterhalter, 2015). As a result of this teacher-student environment fit they were able to exhibit a warm-demander tough-love teaching approach (Bonner, 2014; Atherton & Kingdon, 2012). It is the combination of their Islamic-inspired view of

teaching, the shared lived experience with students and the personal fulfilment they derived from their students' success that provides an explanation for their high expectations, a consistently significant factor in teacher effectiveness (Muijs, et al., 2014).

The ethic of care underpinning teachers' values materialised in concrete ways in their classrooms. Experienced teachers exhibiting expert practices established clear rules which were understood and internalised by students, enabling teachers to focus on developing students' subject expertise (Muijs, et al., 2014). These teachers were socially and emotionally expert, balancing care and humour with expectations of excellent conduct and behaviour to support students' cognitive development in mathematics (Hargreaves, et al., 2017; Bonner, 2014). The resultant classroom environment meant teachers could exercise reciprocative pedagogies, opening up their space to share with students (Zyngier, 2016). It enabled them to practise diminishing control, owning it at the start of the lesson and transferring it to students as the lesson progressed (Rosenshine, 2009).This space created an environment in which students could ask questions and admit to not understanding without fear of embarrassment or failure, developing the ability to engage in critical, reflective dialogue (Affouneh & Hargreaves, 2015).

Inexperienced teachers, mainly teenagers in the younger classes in school-B, exhibited novice practices. They were more overt in their behaviour management and had to exercise it more often. The lack of support to help them translate their ethic of care into constructive pedagogies, combined with the pressure to cover the curriculum, resulted in these teachers resorting to autocratic pedagogies (Affouneh & Hargreaves, 2015).

Nevertheless, what was most surprising for me, with HIC educational experience and research perspective, was the holistic transformative approach to education evident across the schools with teachers conscious of their agentic power (Devine & McGillicuddy, 2016; Zyngier, 2016). They were explicit about education's long-term goal of transforming not just the children alone but their families, the community and the locality (Affouneh & Hargreaves, 2015). In both schools teachers were conscious of culture as a social and political issue and

understood the role education could play in disrupting power hierarchies by opening up opportunities for their students through individual and collective empowerment (Zyngier, 2016). Rather than an individualist worldview, these teachers had a community and collectivist worldview, building on human interdependence in order to serve the larger needs of society (Alexander, 2008, p. 101). They embodied a view of teaching which involves 'issues of moral purpose, emotional investment and political awareness' (Woods, 1996, p. 31).

Teachers' worldview was limited by their skills in translating their values into transformative pedagogies which I discuss next.

5.3 Expert and novice mathematics teaching and learning in Karachi's LCPS-schools

Given the similar values that underpinned teachers' pedagogy; similar view of mathematics as an important, relevant subject; similar starting point of teachers, young, inexperienced and unqualified; and similar starting points of students there were within- and substantial across-school differences in teachers' instructional practices.

Considering the continuum of practice from novice to expert, school-A teachers exhibited more expert practice with its inexperienced teachers exhibiting aspects of expertness whereas school-B teachers consistently exhibited novice practices in the younger classes. As teachers gained experience they developed more expert practices reflecting the fact that knowledge for teaching is constructed in its context (Wilson, 2013; Bau & Das, 2017).

Teachers in both schools acknowledged they continuously needed to learn before they could teach. Reflecting Shulman's (1987, p. 14) position that 'to teach is first to understand', lesson planning was seen as important vehicle by teachers to do this. School-A teachers benefited from detailed teacher-guides to aid their planning. These, combined with online research and support from expert colleagues, developed teachers' substantive and syntactic mathematical knowledge (Rowland, et al., 2009). In contrast, school-B teachers were informed of what to teach, and held to account for it, but not shown how to teach. Given they were inexperienced and unprepared teachers, frequently just

teenagers, they had insufficient guidance to develop their general and pedagogical content knowledge. Consequently, this difference in teachers' propositional structures resulted in a marked difference in their instructional practices and how they used lesson time (Hanushek, et al., 2018).

LCPS teachers with novice practice appear to consider children as imitative learners responding to didactic exposure. They use direct instruction to elicit rote learning in the transmissive tradition, with students either copying or working on their own. Teachers utilising novice practices teach in a rigid, ritualistic and disconnected manner exhibiting an instrumentalist view of mathematics (Smith, et al., 2005; Donovan & Bransford, 2005). Their practice replicates the teacher-led IRF tradition, seeking low-level, one-word confirmatory answers to their product-oriented questions (Smith, et al., 2005). These teachers' limited skills meant that their interventions, rather than developing conceptual understanding by identifying errors and misconceptions, focus more on non-mathematical related inputs (Harvard Business School, 2018).

Signalling limited exposure to underlying ideas of formative assessment (Heitink, et al., 2016), inexperienced teachers do not have the skills to identify errors or the schemas to address these conceptually. Exhibiting novice practice they merely provide the correct answer without addressing the fundamental mathematical misconceptions students may have that gave rise to the errors (Borko & Livingston, 1989). These then compound into subsequent lessons contributing to students' disaffection with mathematics later (Husbands & Pearce, 2012; James & Pollard, 2011). Conversely, teachers with expert practices are skilled in creating a classroom culture that welcomes errors being unearthed and celebrates addressing these. This enables students to attain mastery of concepts (Anderson, et al., 2018) and fosters their autonomy and ownership of learning (Zyngier, 2016).

Teachers with expert practice employed pedagogical reasoning and so were adept at adapting what they were expected to teach to match their students' cognitive levels (Glennerster, 2013). In contrast, the directive in school-B to adhere to the prescribed curriculum irrespective of their students' level and to

check for accuracy by marking students' work in-class appears to be detrimental to student learning. The practice results in teachers teaching what students were not ready to learn and students sitting for extended periods of time with nothing to do (J-PAL, 2013). Given this practice was also seen in the pilot-schools it may be symptomatic of the wider educational culture.

In contrast, teachers with expert practice view children as thinkers and knowledgeable. Their facilitative instructional practices reflect this (Leech & Moon, 1999). They provide guided practice, check understanding, spot errors and draw the class together to address these. They vary students' activities in lessons creating multiple ways to reinforce and rehearse key teaching points. They enact expert practices because they have developed a problem-solving view of mathematics teaching and are adept at developing students' procedural fluency, conceptual knowledge and the strategic competence to use both. They have higher content knowledge and therefore present mathematical ideas more clearly and give better mathematical explanations. Consequently, their students learn more mathematics.

Communication is a tangible feature of expert practice. Through listening to students teachers exhibiting expert practice develop students' conceptual understanding, flexing their teaching and taking side-turns as required (Hill, et al., 2005). These teachers demonstrate the improvisational performance aspect of teaching, reacting in response to student responses, creating theatre in how they add dramatic tension to seatwork or excitement in the way they introduce activities (Borko & Livingston, 1989). Expert practice is marked by an explicit focus on developing mathematical vocabulary in students' home language of Urdu and in English, which in turn enables students to articulate their mathematical reasoning. Teachers with expert practice bounce students' questions onto other students, facilitating student-to-student dialogue and enabling peer-to-peer learning thereby extending the class' collective ZPD.

Exhibiting all the features of Boaler's (2006) multi-dimensional classrooms, LCPS teachers exhibiting expert practice value students asking questions, supporting each other, explaining their ideas and utilising problem-solving approaches using multiple methods. Opportunities to do this arise because

teachers set mathematical activities that can be solved using different methods providing rich discussion opportunities (Knapp, et al., 1995; Murata, 2015). Teachers with expert practice expand their width of instruction and exhibit a constructivist, collaborative view of teaching (Murata, 2015).

There were numerous examples of expert practice, all in school-A, scaffolding students' learning and modelling explanations to develop their conceptual understanding. Teachers utilising expert practice gave mathematical explanations that mathematised students' lived experiences making the subject relevant to them (Bonner, 2014).They used manipulatives to take student knowledge from concrete to abstract, helping students understand how mathematics works (Murata, 2015). Another contrasting feature of expert versus novice practice is the expectation regarding mental calculation (Askew, et al., 1997); while expert practice sets high cognitive challenge for students to use mental calculations novice practice leaves unchallenged even simple calculations undertaken using formal written methods.

The challenge for policy makers is how to get teachers' practice from novice to expert. I turn next to exploring why expert practices dominated in school-A and how this can be developed in other schools.

5.3.1 Moving from novice to expert practice

My findings highlight the variation in teaching practice across LCPS-schools. Andrabi et al's (2013) research in Pakistan entitled 'Students today, teachers tomorrow' perfectly captures school-B's workforce of young, inexperienced, ex-student teachers. Given its instructional practice was similar to that of the pilot-schools, this suggests an urgent need to support LCPS-schools to improve their instructional practices.

Three key aspects of the institutional environment in school-A that were absent in school-B appears to contribute to the development of expert mathematics teaching: first, a structured pedagogy programme that develops teachers' content, curriculum and pedagogical knowledge; second, an ongoing professional development programme that improves their instructional

practices; and third, complementing this a transparent accountability framework which has teachers' respect and buy-in.

5.3.1.1 Structured pedagogy

Recognising that imported textbooks and teacher manuals were failing to address their teachers' skills gap, the chain that school-A belongs to crafted their own teacher-guides with linked textbooks and student-workbooks. Through these teacher-guides teachers developed not just content, curriculum and pedagogical knowledge but importantly their mathematical pedagogical content knowledge (PCK), known to have greater positive correlation with students' learning outcomes than the other aspects alone (Blank & de las Alas, 2010; Coe, et al., 2014). Referred to as structured pedagogy programmes, these have been implemented in several countries and have demonstrated large improvements in students' learning-outcomes (Snilstveit, et al., 2016). These programmes are multi-dimensional in their nature with detailed teacher guides and scripted lesson plans as well as onsite coaching. These, therefore, address coherently the combination of barriers faced in L&MIC such as low teacher knowledge and lack of teaching and learning materials.

While structured pedagogy may seem contentious, impacting on issues of teacher autonomy and professionalism, where capacity is weak the approach has worked (Orr, et al., 2013). Teachers report finding these resources a useful source of guidance to enhance their knowledge and skills. The question of whether structured pedagogy threatens teachers' autonomy can be explored through the concepts of being 'in authority' which a teacher is and being 'an authority' which arises from having deep, formal expertise. If the authority of the teacher-guide producers is considered to be legitimate, justified and serving educational purposes then their materials are seen to have legitimacy, supporting teachers in their endeavour to become an authority (Shalem, et al., 2018). The quality and accessibility of these resources are important, which to inspire legitimacy need to set out the rationale for, as well as the correct and incorrect ways of, teaching content. School-A teachers had high regard for the quality of their teacher-guides recognising it as an authoritative way to inform their own learning.

Often the roll-out of structured pedagogy programmes is accompanied by school visits to test implementation fidelity (Piper, et al., 2016). The personal and professional knowledge acquired about teachers through these visits needs to be used appropriately and non-coercively to maintain the legitimacy of the endeavour. In school-A because of the caring culture created by the headteacher and the camaraderie of the staff as well as teachers' appreciation of the teacher-guides, implementation fidelity checks were not considered intrusive. Rather these were seen as opportunities to learn about improvement. For example, teachers were able to feedback where they thought too many activities were expected to be covered in lessons.

Like the teachers in a South African study (Shalem, et al., 2018), School-A teachers were unanimous in their praise of the teacher-guides seeing these as making their lives easier. Senior leaders in school-A did not demand strict compliance to the resources, rather they expected teachers to adapt and contextualise them. Professional respect was afforded to teachers in encouraging them to experiment with and reflect together on the materials. The South African study found that the materials provided clarity, consistency and stability to the least effective teachers but insufficient attention had been paid to developing teachers' subject knowledge. Therefore, practice improved in only a limited way. In contrast school-A has a systematic method for developing teachers' full knowledge base, which I turn to next.

Exhibiting the professional characteristics of continuous improvement, all the teachers I met wanted to be better teachers and valued training highly. The difference between the schools was that school-A had a planned approach while other schools were at the mercy of externally funded programmes or subject to their limited in-house capacity and resources.

5.3.1.2 Systematic support framework

Interventions to improve subject knowledge of teachers with the lowest starting points benefited their students the most (Hill, et al., 2005). This finding is likely to be pertinent for L&MIC teachers. While action to improve teachers' mathematical knowledge in HIC through content focused training has found to improve students' learning-outcomes (Timperley, et al., 2007), few studies are

available on how to effectively improve L&MIC teachers' knowledge (Glewwe & Muralidharan, 2016).

School-A teachers felt mathematics was an easy subject which students mastered quickly whereas school-B teachers felt it was hard and needed effort to learn. These differing views are likely explained by the support the respective institutions provided to their teachers. In addition to the structured pedagogy programme, school-A had an annual headquarter-devised training programme complemented by monthly school-devised training. These training sessions, including micro-teaching sessions, respond to teachers' specific requests on topics they are struggling with in advance of teaching these to students. This systematic approach gives school-A teachers a professional vocabulary and a common framework from which to support each other to improve (Danielson, 2007). This means teachers with novice practices are able to become expert in stages, developing aspects of their instructional practices.

School-A's environment and institutional processes support teachers in developing a pedagogical language to articulate teaching and learning in a comprehensive, inter-connected way. It gives them 'a language with which to describe, and to celebrate, what teachers know about and others do not' (Rowland, et al., 2009, p. 16). In pilot-school interviews teachers often lacked this. For example, they used assessment practices but did not have a language to describe it, whereas school-A teachers' parlance includes pedagogical terminology such as 'anticipation, building knowledge and consolidation' to describe their lesson structures and 'instructional and concept check goals' to differentiate between what they should do and what students should learn.

School-A had formalised the process of collaboration with training enhanced by in-school teacher coaching and weekly demo- or team-teaching lessons creating a 'highly collaborative' school culture (Boaler, 2006, p. 365). Teachers were expected to and did support each other to co-develop their content and pedagogical knowledge. This all resulted in a collaborative community of practice within individual schools and across the chain's schools, a peer network for school improvement. Individuals in this peer network researched,

experimented and shared practice, converting research knowledge into practical, context specific, tacit craft knowledge (Wilson, 2013).

Communicative, dialogic teaching as practised by teachers in school-A requires considerable confidence and expertise on the part of the teacher in addition to a pedagogical view that may be very different to the one the teacher herself experienced. By combining training with in-school coaching this expertise was built. The teacher-guides and training made explicit the science of teaching and demo-lessons, team- and micro-teaching made explicit the craft of teaching (Woods, 1996).

5.3.1.3 A systematic, transparent accountability framework

Improving teacher accountability can be a cost-effective way of improving learning outcomes (Glennerster, 2013; World Bank, 2012). While school-B's accountability processes focussed on thin inputs: teacher attendance, syllabus coverage and books marked, school-A focused on thick implementation-intensive inputs such as the quality of teaching (Pritchett, 2014).

School-A teachers were evaluated in a range of formal ways: checks on lesson planning and reflection; lesson observations; book reviews; student test scores; and annual teacher tests scores. This is an intensive set of accountability criteria and while teaches were critical of some documentation demands, they were surprisingly positive about the accountability system. This gave them standards to aim for as well as autonomy and pathways through which to do so (Pritchett, 2014). They saw the 'checks and balances' evaluation system almost as a badge of honour, contributing to the quality associated with the chain and differentiating them from other teachers, setting an example of best practice (Tichenor & Tichenor, 2004). The accountability system contributed to a professional culture of continuous improvement because it was matched with a formal improvement support system. An accountability system alone without the high level of support would have likely not been received as well.

The school's system had coherence within relationships of accountability from the chain to the headteacher to teachers, all motivated and informed about improving students' affective and academic outcomes (Pritchett, 2015). For

example, student assessment identified mathematics topics which students performed less well in. This then was designated a priority in the school improvement plan which led to school and headquarter level training. Subsequent monitoring and evaluation by senior leaders focused on improvements of these micro aspect, making the whole process aligned and focused for teachers. A similar process was taken for topic areas identified through teachers' subject competency tests.

Another aspect of the accountability mechanism in school-A was the student assessment system. Like countries that improved their students' learning outcomes using frequent assessments to hold teachers to account, school-A also used this principle (Mourshed, et al., 2010). They used information from these to change curriculum and instructional practices, developing a feedback loop of teaching, assessing, re-teaching and then re-assessing (Bruns, et al., 2011). School-A's comprehensive student assessment process enabled teachers to identify students' current cognitive level and plan future teaching in order to help them achieve beyond it (Fullan, 2010). Rather than stream students, the class teachers collaborated closely with remedial teachers to ensure alignment on the knowledge gaps to address, supporting students to catch up with their peers (Zyngier, 2016; Duflo, et al., 2011).

Having discussed teachers' instructional practices in the LCPS, I turn my attention to the sector itself arguing for the need to support its improvement given the high proportion of poor students attending LCPS-schools.

5.4 The low-cost private sector

The issue with Pakistan's education sector is that while the best government schools compare favourably with the best private schools, the long tail of poor-quality government schools is outperformed by LCPS-schools (Andrabi, et al., 2009). A powerful statistic from their research notes that the gap between mathematics scores of government and private schools is eight times the gap between that of children of literate and illiterate parents, suggesting factors such as teacher performance rather than poverty are at play.

The rapid rise of LCPS in Pakistan is well documented (Andrabi, et al., 2008) and with nearly half the children in Karachi attending private schools, it is a sector that cannot be ignored (Pakistan Bureau of Statistics, 2012). Even critics of the sector acknowledge it has a role to play with their main concern being equity (Watkins, 2012). The poor are focusing their resources in the LCPS (Sandefur, 2012) but the poorest are not able to (Heyneman, et al., 2012). Therefore, the focus of government and donor efforts should be on the full spectrum of education provision. It should include support to the LCPS to improve its provision but also consider the equity implications of provision which the poorest do or do not access (Patrinos, et al., 2009). Ignoring this sector is likely to lead to greater inequity and segregation of communities, as those with resources go private and the remainder go government or do not go at all.

In resource-limited environments non-state actors can be an additional means of addressing issues of educational quality and access with government taking on the role of commissioner and regulator of education rather than the provider (LaRocque, 2008). This will require it to take forward public private partnerships, which the Sindh government has already instigated with school-A's headquarters. Benefits of such partnerships include reduced corruption, transparent costs, competitive pressures driving quality upwards and circumvention of restrictive employment laws and pay scales. Risks are exploitation of the workforce, loss of control by government and uneven distribution of benefit linked to equity (LaRocque, 2008). However, these risks and more are already evident in Sindh's public-sector provision, including political contestation which shapes public servants' incentives and norms extracting private benefit rather than public goods such as unaccountable selection process and unaddressed poor performance (Khemani, 2019). The LCPS does not have the scale and reach of the government sector, nor the mechanism to access its resources such as training and teaching and learning materials. Therefore, while government works on improving the public sector, it also needs to include the LCPS in its improvement efforts.

The LCPS provides young females in a patriarchal society with an acceptable way to address the financial hardships that lead to their entry into the job market

(Andrabi, et al., 2013). While in the broader context teaching may be considered a last resort profession, because of the characteristics of the particular schools teachers worked in they and their communities viewed it as a respectful vocation, giving them a sense of pride (Shiraz & Qaisar, 2017; Singh & Sarkar, 2012). Considering how these teachers can be further supported should be part of government's education improvement endeavours.

My findings show the LCPS is eager for and would benefit from professional development. Rather than needing to be provoked to change their practice they are keen for support in doing so (Black & Wiliam, 1998). Fee-paying parents will vote with their feet to leave LCPS-schools providing the sector with powerful incentives to improve (World Bank, 2012). Government's role with regards to this ever-growing sector in response to parental demand should be to set standards, establish mechanisms to evaluate whether these are met, and provide resources to help schools to improve as it has a responsibility to educate all. The LCPS is not going to go away.

5.5 Summary

Too often in education in international development solutions developed in HIC are transported to L&MIC. Alexander (2000) cautions against this internationalisation of pedagogy which ignores the cultural context, and resource and system capability variances in the receiving country. Despite the significant resources spent by countries and donors on policies, programmes and projects to improve service delivery, Andrews et al (2017) argue that little has changed at the chalk face because it is implementation capability which renders countries to be stuck. The chain that school-A belongs to developed their own intellectual and professional capital, and implementation capability to address their own local problems.

While my study used HIC literature in the absence of L&MIC grounded literature against which to compare Karachi's LCPS-teachers' practice international comparisons should not be abused (Alexander, 2000). Capability is not acquired by importing solutions but by focusing on local problems, identifying exemplars and 'by persistent practice' not imitation (Andrews, et al., 2017, p. 28). Further research is needed, and research capability developed, including of

teachers, using mixed-method approaches to understand teachers' motivations, their practices and the systems in which they operate to bring about sustainable improvement.

In his five-country study, Alexander (2000, p. 359) found in India 'an impermeable core to some teaching of low expectations and undemanding tasks'. My findings do highlight undemanding tasks set by teachers with novice practices but this was not driven by low expectations, rather it was due to a lack of knowledge, support and systematic professional development which left teachers to practise what I call the pedagogy of the unskilled rather than the pedagogy of indifference, utilising transmissive, rigid ritualistic instructional practices (Lingard, 2007).

School-A shows with systematic development, grounded in teachers learning from each other, low-skilled and low-qualified teachers can be supported to enact expert practices evident of transformative pedagogies. This can result in sustained, collaborative engagement that is responsive to teachers' needs, informed by their practice and inspired by relevant localised research (Hargreaves, 2013b). This is important learning for the international community given the shortfall of 69 million teachers estimated by UNESCO (2016) and the rapid rise of the LCPS whose business model is based on the availability of inexperienced, unqualified teachers. A way forward would be to study school-A's work more deeply from a policy perspective, disseminate their resources and consider how it has addressed the scale challenge. Through their collaboration with government this journey has begun.

Teachers can mitigate inequality but they need systematic support, including consistent policy frameworks, to improve and address these inequalities (Masino & Nino-Zarasua, 2016). My proposition that features of good teaching are universal bore out. In illuminating teachers' expert practices, contextualised and localised to the site of under-privileged students attending LCPS-schools in Karachi, I present a more optimistic and nuanced contribution to the L&MIC research literature.

Next, I consider the implications of these findings.

Chapter 6 Reflections, implications and recommendations

In this final chapter I reflect on my research methodology, consider the implication of my research and make recommendations for policymakers working in L&MIC. I conclude by considering areas for further research.

I begin by reflecting on the importance of using a school effectiveness and improvement (SEIR) lens in educational research in L&MIC to provide greater detail regarding what works in these contexts.

6.1 Reflections on research methodology

Research in L&MIC focuses predominantly on system level issues with little detail of effective teaching and learning practices that are usable by practitioners or policymakers (Duflo, et al., 2012; Piper, et al., 2018). In contrast, teacher effectiveness research in HIC focusses on the measurable behaviours which have an impact on student outcomes to build up an understanding of effective teaching (Muijs, et al., 2014). Similar research is needed in L&MIC to produce localised and contextualised solutions for school improvement. Like all schools LCPS-schools need to be part of this improvement effort.

Since the 1990s there has been a move in HIC to integrate school effectiveness research (SER), which is predominantly quantitatively orientated and academic-led with qualitatively oriented, practitioner-led school improvement research (Reynolds, et al., 1996). The proposition underpinning this integration was to elicit deeper knowledge about good quality schools and a conviction that when the two merge teachers are empowered towards higher effectiveness (Reynolds, et al., 1993). The rationale for SEIR was to integrate the relationships demonstrated by the quantitative data with the explanation for these relationships through qualitative study. The discipline is also considering its relevance in L&MIC countries:

> ‘To think and act both locally and globally suggests that the developed world may have some responsibility to support poorer countries to enable their young people to attend school in the first place, and then to maximize their school quality’ (Reynolds, et al., 2011, p. no page numbers).

For this to not become a HIC transplantation exercise, research originating from L&MIC by and of its educational practitioners rather than just by econometricians needs to be supported. Educational research in international development, like the quantitative data used in this thesis, is often at the household level as opposed to the school and classroom level. This means that school level data, let alone classroom level data, is not available to answer the 'what works' question.

Although critics argue for the separation of SEIR from government policymaking where it can appear to place improvement responsibility on schools rather than on governments (Goldstein & Woodhouse, 2000), in L&MIC it can set a useful starting point in identifying a finite set of improvement priorities. If learning outcomes are to improve, research questions need to be more precise, such as which pedagogical aspects teacher training should focus on and how to develop these at scale. Production model economists have shown what does not work in relation to inputs but specifics in relation to what does work in instructional practices are lacking (Day, et al., 2014; Aslam & Kingdon, 2011). Research questions rooted at the classroom level rather than on inputs and attributes have been shown to make a difference to students' learning-outcomes (Reynolds, et al., 2011). Evidence that schooling makes a difference was endorsed in my quantitative analysis, however, how and why some schooling makes more of a difference than others needs further study.

While a sophisticated SER approach can be expensive given the difficulty of acquiring data, more pragmatic approaches are available. For example, utilising existing data sources, albeit crude, such as ASER (2016) at the school level, rather than household level, can provide a proxy SEIR approach.

6.1.1 My pragmatic proxy SEIR methodology

While my mixed-methods, case-study methodology provided me with a rich source of data, my intention to use SEIR methodology was frustrated by delays in acquiring data and because it was available only at the household level. I had to take a pragmatic approach to the in-depth case-study school selection, identifying exemplars from the pilot-schools and using the reputation of the school-A chain. Nevertheless, these presented two contrasting views of LCPS-

schools and provided much detail on teachers' expert and novice instructional practices and the values that underpin it.

The mixed-methods approach enabled a qualitative study of classroom practice which was illuminating. Using a note-taking approach to lesson observations provided me with rich data in order to exemplify expert and novice aspects of mathematics teachers' practice contextualised and in some cases topic specific. For example, different practices in teaching place value and multiplication. While still in infancy, the international development sector is making increasing use of classroom observation tools such as CLASS and Stallings (Bruns, et al., 2016). However, these appear to be measuring endeavours rather than school improvement initiatives, often taking a tick box approach. While these are useful they are limited in their ability to provide teachers with subject-specific information on developing their craft knowledge and fail to illuminate why teachers took the decisions they did.

My research methodology highlighted the importance of teachers' voice. Without my interviews powerful account of teachers' values would not have surfaced. These resulted in a more nuanced, more positive understanding of the profession in L&MIC, whereas research too often cites its inadequacies.

6.1.2 Personal reflection

In the process of conducting research I had to set aside my professional inspection experience, reminding myself that as a researcher my role was to describe, explore and understand teaching, not evaluate it. This required conscious unlearning of professional skills acquired over many years. The pilot phase was helpful in making this explicit, so by the time the in-depth field visits took place I had developed a stronger researcher/academic orientation.

If I was to repeat this study I would use my own assessment tests, freeing me from data dependency on external sources. Alternatively, I would locate the study in Punjab where school-level data is available. I would also like to study more exemplar schools and expand my interviews to students and parents as this will add wider perspectives on exemplar schools. Security concerns as well as my time and cost limitations meant I could not spend more time in Karachi.

My intention in identifying exemplar LCPS-schools was to illuminate their practice in order to produce a grounded, localised version of expert practice to inform school improvement. My starting proposition that good quality teaching is universal was borne out. Despite this I was often surprised by teachers' expert practice and questioned whether this was due to a deficit view of the context. On reflection, my surprise was not due to the fact that on paper these were unskilled, poorly paid, unqualified teachers teaching in Karachi's poorest areas, it was simply that their teaching was so consistently good. It was a delight to experience and reflected the same emotions I experienced observing good teaching in deprived settings in England. It shows what is possible and what good can and should look like.

I have supported numerous mathematics teachers and inspected hundreds of lessons in England and so have a good comparator. I was impressed at the level of mathematical knowledge exhibited by school-A teachers, and their students, and teachers' skills in developing conceptual understanding without the relatively considerable resources available to English teachers. Their lessons were mathematically-demanding fun places to be and provide a hopeful foundation for considering how resource-constrained environments can deliver effective teacher professional development.

The process of observing the contrasting institutional environments as well as the poverty context in which both the students and teachers lived was humbling. It increased my understanding of educational development, the complexities of educational improvement and made me experientially informed about the interconnection between elements of school and system improvement, and how system coherence can result in transformative education. But most of all it made me hopeful, about the transformative potential of education, and inspired by the people engaged in bringing it about.

In summary, rather than just commissioning research on broad policy areas such as the impact of the LCPS, policymakers and donors should utilise SEIR methodologies to help identify exemplar schools and investigate how and why they are making a difference. Conversely schools at the other end of the spectrum can also be studied to provide a juxtaposition; comparing the practice

of novice and expert schools, in a similar way to novice and expert practices of teachers can identify policy directions linked to implementation capabilities. This will provide a strong foundation to inform context specific school improvement work.

6.2 Policy recommendations based on the research findings

This research of mathematics teaching and learning in Karachi's LCPS leads to the following policy recommendations:

1. Provide professional development to LCPS teachers on mathematics teaching and learning, focusing particularly on:
    a. developing students' conceptual understanding and problem-solving skills through effective scaffolding and guided practice;
    b. embedding formative assessment to address mathematical errors and misconceptions;
    c. developing teachers' dialogic' instructional practices with a focus on promoting mathematical communication.
2. Invest in the LCPS sector in three ways:
    a. Support government in regulating this sector
    b. Investigate and address thoughtfully and pragmatically the equity implications of the poor accessing the LCPS but not the poorest;
    c. Make resources that already exists, such as school-A's structured pedagogy programme, available to LCPS teachers to develop their instructional practices.
3. Use SEIR methodology to commission research that seeks to identify what works at the classroom level in L&MIC to focus school improvement activities by:
    a. Using existing data to develop a pragmatic approach to SEIR in order to ascertain which schools are adding more value and research these schools to understand why;

b. Researching further how teachers' expert and novice practices differ and the pathway from novice to expert practice;

c. Support the development of bottom-up, localised, context-specific school improvement mechanism such as collaborative communities of practice which utilise this research.

6.3 Implications of the findings

There are four key audiences whose work has implications from my findings:

6.3.1 My own professional role

This study endorsed my professional belief that improving teaching is key to improving learning-outcomes. As governments and donors increasingly focus on educational quality, the focus has to be more nuanced on what teachers do to improve learning.

At the field visit stage of this research I was a HMI training inspectors and headteachers in England, and the literature review provided a powerful theoretical underpinning to my work in schools and with professionals. Towards the end of this research I had become the team leader for the Girls' Education Challenge (GEC). This is a DFID funded programme working in 18 countries with the aim of improving learning outcomes for marginalised girls. This research has provided a solid foundation for taking forward the importance of teaching and learning in the GEC and utilising its assessment information in order to promote a SEIR methodology. Currently I am a policy lead on global education where academic rigour, availability and accessibility of education research has even more relevance as we search for effective ways to support systemic reform and reflect on the data, evidence and research available for policymakers and practitioners to do so.

6.3.2 Donors

Donors remain deeply interested in what works to improve learning-outcomes and fund programming and research. My research was centred on an innovative DFID programme which was seeking to harness the potential of the LCPS. I have already shared my findings with DFID Pakistan and will produce a

two-page summary for donors and funders, setting out key findings and recommendations, including on research methodologies.

6.3.3 Departments of Education in Pakistan

Pakistan has a substantial LCPS and consideration is being given by government as to how to regulate and support the sector. I will share my research summary with Pakistan's provincial departments of education in order to support their school improvement efforts, with a particular focus on continuous professional training approaches for LCPS teachers. I will also share the findings with organisations that regulate and support the LCPS for the same reasons.

6.3.4 Practitioners working in L&MIC

My professional role as DFID's Girls' Education Challenge lead is where I see this research being most fully utilised. I plan to share the literature and findings chapter with the team. I will also work with the projects directly to promote effective instructional practices as part of their development programmes, through webinars, blogs and sharing of best practice.

6.4 Recommendations for future research

My thesis has the potential to off-shoot research in several directions:

- At the micro level, this study focused on teaching and learning in mathematics. Given students' learning-outcomes were higher in mathematics, and this study highlighted differences between teachers' expert and novice practice in the subject, there is a need to undertake similar research in literacy. It is also worth exploring how this focus and research methodology applies to government schools and other provinces of Pakistan, considering rural areas beyond the urban area I studied.

- My research findings suggest undertaking an action research project as a next step. If the pilot-schools and school-B had access to school-A's resources and training programmes, how would this impact on their instructional practices?

- A comment by a school-A teacher struck me as prescient. She noted the chain recruited *dilwale* (with heart) and made them into *dimaghwale* (thoughtful and with skills). This implies particular characteristic were sought at the recruitment stage suggesting it is worth researching what these are.

At a macro level, it is important to use the SEIR lens when conducting research in L&MIC (Coleman & Earley, 2005). This is to ensure that the considerable investment donors are making, not to mention cash-strapped L&MIC themselves, is focused on the right things. There has to be a move away from input led research models to quality led methodologies which demonstrate a greater understanding of what teachers are doing in the classroom and why.

Bibliography

Affouneh, S., & Hargreaves, E. (2015). Fear in the Palestinian Classroom: pedagogy, authoritarianism and transformation. *Pedagogies: An International Journal, 10*(3), 222-237.

Alderman, H., Orazem, P. F., & Paternoc, E. M. (2001). School Quality, School Cost, and the Public/Private School Choices of Low-Income Households in Pakistan. *Journal of Human Resources, 36*, 304-326.

Alexander, R. (2000). *Culture and Pedagogy International Comparisons in Primary Education.* Oxford: Blackwell Publishers.

Alexander, R. (2008). *Essays on Pedagogy.* Abingdon: Routledge.

Ali, A. A., & Ried, N. (2012). Understanding Mathematics: Some Key Factors. *European Journal of Educational Research, 1*(3), 283-299.

Alif Ailaan. (2015). *Not free at all: Profiling the costs parents incur on education.* Islamabad: Alif Ailaan.

Amirali, M., & Halai, A. (2010). Teachers' Knowledge about the Nature of Mathematics: A Survey of Secondary School Teachers in Karachi, Pakistan. *Bulletin of Education and Research, 32*(2), 45-61.

Anderson, L. W., & Burns, R. B. (1987). Values, Evidence, and Mastery Learning. *Review of Educational Research, 57*(2), 215-223.

Anderson, R. K., Boaler, J., & Dieckmann, J. A. (2018). Achieving Elusive Teacher Change through Challenging Myths about Learning: A Blended Approach. *Education Sciences, 8*(98).

Andrabi, T., Das, J., & Asim, K. (2013). Students Today, Teachers Tomorrow: Identifying constraints on the provision of education. *Journal of Public Economics*.

Andrabi, T., Das, J., & Khwaja, A. I. (2008, August). A Dime a Day: The Possibilities and Limits of Private Schooling in Pakistan. *Comparative Education Review, 52*(3), pp. 329-355.

Andrabi, T., Das, J., & Khwaja, A. I. (2015, March 21). *The Impact of Providing School and Child Test Scores on Educational Markets.* Retrieved from The World Bank: http://documents.worldbank.org/curated/en/789721468191341184/pdf/WPS7226.pdf

Andrabi, T., Das, J., & Khwaja, A. I. (2016, June). *Report Cards: The Impact of Providing School and Child Test Scores on Educational Markets.* The World Bank. Harvard Kennedy School.

Andrabi, T., Das, J., Khwaja, A. I., Vishwanath, T., & Zajonc, T. (2009). *Learning and Educational Achievements in Punjab Schools (LEAPS): Insights to inform the education policy debate.* Washington: World Bank.

Andrews, M., Pritchett, L., & Woolcock, M. (2017). The big stuck in state capability: Evidence, Analysis, Action. In *Building State Capability* (pp. 9-28). Washington DC: Oxford Scholarship Online.

Anjum, R. (2006). The Impact of Self-efficacy on Mathematics Achievement of Primary School Children. *Paksitan Journal of Psychological Research, 21*(3), 61-78.

ASER. (2016, August 2). *Annual Status of Education Report*. Retrieved from Inforgraphics: http://aserpakistan.org/infographics

ASER-Pakistan. (2015). *Annual Status of Education Report 2015 - Urban.* Islamabad: ASER.

Ashley, L., Mcloughlin, C., Aslam, M., Engel, J., Wales, J., Rawal, S., . . . Rose, P. (2014). *The role and impact of private schools in developing countries.* Department for International Development.

Askew, M., Brown, M., Rhodes, V., Wiliam, D., & Johnson, D. (1997). *Effective Teachers of Numeracy: Report of a study carried out for the Teacher Training Agency.* London: King's College, University of London.

Aslam, M. (2009). The relative effectiveness of government and private schools in Pakistan: Are girls worse off? *Education Economics*, 329-353.

Aslam, M., & Kingdon, G. (2011, June). What can teachers do to raise pupil achievement? *Economics of Education Review, 30*(3).

Atherton, P., & Kingdon, G. (2012). *The relative effectiveness and costs of contract and regular teachers in India.* Oxford: CSAE working paper series.

Banerjee, A. V., Cole, S., Duflo, E., & Linden, L. (2007). Remedying Education: Evidence from Two Randomized Experiments in India . *The Quarterly Journal of Economics, 122*(3), 1235–1264.

Banerjee, A., Banerji, R., Berry, J., Duflo, E., Kannan, H., Mukherji, S., . . . Walton, M. (2016). *Mainstreaming an Effective Intervention: Evidence from Randomised Evaluations of 'Teaching at the Right Level' in India.* Massachusetts: National Bureau of Economic Research.

Banerjee, A., Banerji, R., Duflo, E., Gelnnerster, R., & Stuti, K. (2010). Pitfalls of participatory programs: evidence from a randomized evaluation in education in India. *American Economic Journal: Economic Policy, 2*(1), 1-30.

Bannerjee, A., & Duflo, E. (2011). *Poor economics.* London: Penguin.

Barakat, S., Hardman, F., Rohwerder, B., & Rzeszut, K. (2014). *The evidence for the sustainable scale up of low cost private schools in South West Asia.* London: EPPI Centre.

Barbour, R., & Schostak, J. (2005). Interviewing and Focus Groups. In B. Somekh, & C. Lewin (Eds.), *Research methods in the social sciences* (pp. 41-48). London: Sage Publication.

Basit, T. N. (2010). *Conducting Research in Educational Contexts.* London: Continuum International Publishing Group.

Bau, N., & Das, J. (2017). *The Misallocation of Pay and Productivity in the Public Sector: Evidence from the Labor Market for Teachers.* Washington: World Bank.

BBC news. (2016, April 20). *Pakistan polio: Seven killed in anti-vaccination attack*. Retrieved December 21, 2016, from BBC news: http://www.bbc.co.uk/news/world-asia-36090891

Biddix, P. (2017, August 28). *Instrument, Validity, Reliability*. Retrieved from Research rundowns: https://researchrundowns.com/quantitative-methods/instrument-validity-reliability/

Black, P. (2015). Formative assessment - an optimistic but incomplete vision. *Assessment in Education: Principles, Policy & Practice, 22*(1), 161-177.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning: Principles, Policy & Practice. *Assessment in Education*, 7 - 74.

Blank, R. K., & de las Alas, N. (2010). *Effects of Teacher Professional Development on Gains in Student Achievement: How Meta Analysis Provides Scientific Evidence Useful to Education Leaders.* Washington DC: Society for Research on Educational Effectiveness.

Bloom, B. S., & Carroll, J. B. (1971). *Mastery learning: Theory and practice.* New York: Holt, Rinehart and Winston.

Boaler, J. (2006). A Multidimensional Mathematics Approach with Equitable Outcomes. *Phi Delta Kappa, 87*(5), 364-369.

Boaler, J. (2016). *How to Learn Math: For Students*. Retrieved December 30, 2018, from https://lagunita.stanford.edu/courses/Education/EDUC115-S/Spring2014/courseware/f515a0dc685345bbb60e4047a57b2440/17ee459d681f4863970f450b7ca2295c/?activate_block_id=i4x%3A%2F%2FEducation%2FEDUC115-S%2Fsequential%2F17ee459d681f4863970f450b7ca2295c

Boaler, J. (2016). *Mathematical Mindsets.* San Francisco: Jossey-Bass .

Bold, T., Filmer, D., Martin, G., Molina, E., Stacy, B., Rockmore, C., . . . Wane, W. (2017). Enrollment without Learning: Teacher Effort, Knowledge, and Skill in Primary Schools in Africa. *Journal of Economic Perspectives, 31*(4), 185–204.

Bold, T., Filmer, D., Molina, E., & Svensson, J. (2018). *The Lost Human Capital: Teacher Knowledge and Student Achievement in Africa.* Washington: World Bank.

Bonner, E. (2014). Investigating practices of highly successful mathematics teachers of traditionally underserved students. *Educ Stud Maths, 86*, 377-399.

Borko, H., & Livingston, C. (1989). Cognition and Improvisation: Differences in Mathematics Instruction by Expert and Novice Teachers. *American Educational Research Journal, 26*(4), 473-498.

Braun, H., Kanjee, A., Bettinger, E., & Kremer, M. (2006). *Improving Education Through Assessment, Innovation and Evaluation.* Massachusetts: American Academy of Arts and Science.

Brinkmann, S. (2018). Teachers' beliefs and educational reform in India: from 'learner-cenered' to 'learning-centred' education. *Comparative Education, 55*(1), 9-29.

Brombacher, A., Nordstrum, L., Davidson, M., Batchelder, K., Cummiskey, C., & Kng, S. (2014). *National baseline assessment for the 3Rs (reading, writing, and arithmetic) using EGRA, EGMA, and SSME in Tanzania.* Tanzania: USAID.

Bruns, B., Filmer, D., & Patrinos, H. (2011). *Making schools work: new evidence on accountability reforms.* Washington: The World Bank.

Bruns, B., Gregorio, S. D., & Taut, S. (2016). *Measures of Effective Teaching in Developing Countires.* London: Research on Improving Systems in Education, RISE. Retrieved from https://assets.publishing.service.gov.uk/media/5891be55ed915d4538000040/RISE_WP-009_Bruns.pdf

Centre for Education Statistics and Evaluation. (2017). *Cognitive load theory: Research that teachers really need to understand.* Sydney: NSW Department of Education. doi:Sweller, Ayres, Kalyuga 2011 Springer

Chapman, C., Armstrong, P., Harris, A., Muijs, D., Reynolds, D., & Sammons, P. (2012). *School effectiveness and improvement research, policy and practice.* Abingdon: Routledge.

Chaudhury, N., Hammer, J., Michael Kremer, K. M., & Rogers, F. H. (2006). Missing in Action: Teacher and Health Worker Absence in Developing Countries. *Journal of Economic Perspectives, 20*(1), 91–116.

Chingos, M. M., & Peterson, P. E. (2011). It's easier to pick a good teacher than to train one: Familiar and new results on the correlates of teacher effectiveness. *Economics of Education Review, 30*(3), 449-465.

Clarke, D. J. (2013). Contigent conceptions of accomplished practice: the cultural specificity of discourse in and about the mathematics classroom. *Mathematics Education, 45*, 21-33.

Clarke, R. E., Kirschner, P. A., & Sweller, J. (2012). Putting students on the path to learning: The case for fully guided instruction. *American Educator*, 6-11.

Coe, R., Aloisi, C., Higgins, S., & Major, L. E. (2014). *What makes great teaching? Review of the underpinning research.* The Sutton Trust.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education* (7 ed.). Abingdon: Routledge.

Coleman, M., & Earley, P. (2005). *Leadership and Management in Education: cultures, change and context.* Oxford, New York: Oxford University Press.

Connor, C. M., Morrison, F. J., Fishman, B. J., Ponitz, C. C., Glasney, S., & Underwood, P. S. (2009). The ISI Classroom Observation System: Examining the literacy instruction provided to individual students. *Educational Researcher*, 85-99.

Corringer, R. G., & Valli, L. (2009). Where is the action? Challenges to studying the teaching of reading in elementary schools. *Educational Researcher*, 100-108.

Cotton, K. (1988). *Instructional Reinforcement.* Portland: Northwest Regional Educational Laboratory.

Creemers, B. P., & Kyriakides, L. (2011). Critical analysis of the current approaches to modelling educational effectiveness: The importance of establishing a dynamic model. *School Effectiveness and School Improvement, 17*, 347–366. Retrieved from http://www.rug.nl/staff/b.p.m.creemers/testing_the_dynamic_model_of_educational_effectiveness.pdf

Cueto, S., Guerrero, G., Leon, J., Zapata, M., & Freire, S. (2014). The relationship between socioeconomic status at age one, opportunities to learn and achievement in mathematics in fourth grade in Peru. *Oxford Review of Education, 40*(1), 50-72.

Cueto, S., León, J., Sorto, M. A., & Miranda, A. (2017). Teachers' pedagogical content knowledge and mathematics achievement of students in Peru. *Educational Studies in Mathematics , 94*(3), 329-345.

Damon, A., Glewwe, P., Wisniewski, S., & Sun, B. (2016). *Education in developing countries – what policies and programmes affect learning and time in school?* Stockholm: Expertgruppen för biståndsanalys (EBA).

Danielson, C. (2007). *Enhancing professional practice: a framework for teaching* (Second ed.). ACSD.

Day, L. A., Mcloughlin, C., Aslam, M., Engel, J., Wales, J., Rawal, S., . . . Rose, P. (2014). *The role and impact of private schools in developing countries.* London: Department for International Development.

Depaepe, F., Verschaffel, L., & Kelchtermans, G. (2013). Pedagoical content knowledge: A systematic review of the way in which the concept has pervaded

mathematics educational research. *Teaching and Teacher Education, 34*, 12-25.

Devine, D., & McGillicuddy, D. (2016). Positioning Pedagogy - a matter of children's rights? *Oxford Review of Education, 42*(4), 424-443.

DFID. (2013). *Education Fund for Sindh Business case.* London: Devtracker. Retrieved from https://devtracker.dfid.gov.uk/projects/GB-1-202378/documents/

DFID. (2013). *Education position paper: Improving learning, expanding opportunities.* London: DFID.

Donovan, M. S., & Bransford, J. D. (2005). Pulling threads. In M. S. Donovan, & J. D. Bransford (Eds.), *How students learn: Mathematics in the classroom* (pp. 569–590). Washington: National Academies Press.

Duflo, E., Dupas, P., & Kremer, M. (2011). Peer Effects, Teacher Incentives, and the Impact of Tracking: Evidence from a Randomized Evaluation in Kenya. *American Economic Review, 101*(5), 1739–74.

Duflo, E., Hanna, R., & Ryan, S. P. (2012). Incentives Work: Getting Teachers to Come to School. *American Economic Review , 102*(4), 1241-1278.

Dweck, C. (2006). *Mindset: The New Psychology of Success.* New York: Random House.

Education Fund for Sindh. (2015, February). School visits. Karachi, Pakistan.

Evans, D. K., & Yuan, F. (2017). *The Economic Returns to Interventions that Increase Learning.* Washington: World Bank.

Evans, D., & Popova, A. (2015). *What really works to improve learning in developing countries? An analysis of divergent findings in systematic reviews.* Washington: World Bank Group. Retrieved from What Really Works to Improve Learning in Developing Countries ?

Evertson, C. E., Anderson, C., Anderson, L., & Brophy, J. (1980). Relationship between classroom behaviors and student outcomes in junior high mathematics and English classes. *American Educational Research Journal, 17*, 43–60.

Fennel, S. (2012). Why girls' education rather than gender equality? The strange political economy of PPPs in Pakistan. In S. L. Robertson, K. Mundy, A. Verger, & F. Menashy, *Public private partnerships in education: new actors and modes of governance in a globalizing world* (p. 320). Chelthenham: Edward Elgar Publishing.

Flanders, N. (1970). *Analysing Teacher Behavior.* Reading: Addison-Wesley.

Fullan, M. (2010). *All systems go: the change imperative for whole system reform.* California and London: Gorwin and Sage.

Gabrielatos, C. (2014, 01 09). *Discerning Reality: Lesson observation as research.* Retrieved 08 06, 2016, from www.gabrielatos.com: http://www.gabrielatos.com/Observations.pdf

Garratt, D., & Li, Y. (2005). The foundations of experimental/empirical research methods. In B. Somekh, & C. Lewin, *Research methods in social science* (pp. 198-206). Sage.

Glennerster, R. (2013, April 15). Improving learning in primary education. *Lessons from a comparative cost-effective analysis*. Presentation to DFID UK: J-PAL Massachusetts Institute of Technology.

Glewwe, P., & Muralidharan, K. (2016). Improving Education Outcomes in Developing Countries: Evidence, Knowledge Gaps, and Policy Implications. *Handbook of the Economics of Education, 5*, 653-743.

GMR Policy Paper 4. (2012). *Global Monitoring Report: Reaching out-of-school children is crucial for development.* Education For all.

Golafshani, N. (2003, December). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report, 8*(4), 597-607. Retrieved from http://nsuworks.nova.edu/tqr/vol8/iss4/6/

Goldstein, H., & Woodhouse, G. (2000). School effectiveness research and education policy. *Oxford Review of Education, 26*(3), 353-363.

Greene, J., Kreider, H., & Mayer, E. (2005). Combining qualitative and quantitative methods in social inquiry. In B. Somekh, & C. Lewin, *Research methods in the social sciences* (pp. 274-281). London: Sage Publication.

Halai, A. (1998). Mentor, Mentee, and Mathematics: A story of professional development. *Journal of Mathematics Teacher Education, 1*, 295-315.

Hamilton, L., & Corbett-Whittier, C. (2013). *Using case study in education research.* Los Angeles: SAGE.

Hanushek, E. A., & Woessmann, L. (2007). *The role of school improvement in economic development.* University of Munich and CESifo.

Hanushek, E. A., Piopiunik, M., & Wiederhold, S. (2018). The Value of Smarter Teachers: International Evidence on Teacher Cognitive Skills and Student Performance. *Journal of Human Resources*.

Haq, R. u. (2014). *Magnitude and correlates of out-of-school children in Pakistan: Evidence from Benazir Income Support Program Census.* BISP. Government of Pakistan.

Hargreaves, E. (2005). Assessment for learning? Thinking outside the (Black) box. *Cambridge Journal of Education*, 213-224.

Hargreaves, E. (2013a). Inquiring into children's experiences of teacher feedback: reconceptualising Assessment for Learning. *Oxford Review of Education, 39*(2), 229-246.

Hargreaves, E. (2013b). Assessment for Learning and Teacher Learning Communities: UK teachers' experiences. *Teaching Education*, 327-344.

Hargreaves, E., Elhawary, D., & Mahgoub, M. (2017). 'The teacher who helps children learn best': affect and authority in the traditional primary classroom. *Pedagogy, Culture and Society, 26*(1), 1-17.

Hart, S., Dixon, A., Drummond, M. J., & McIntyre, D. (2004). *Learning without Limits.* Maidenhead: Open University Press.

Harvard Business School. (2018). *Centre for Educational Policy Research*. Retrieved December 28, 2018, from https://cepr.harvard.edu/mqi

Hattie, J. (2003). Teachers Make a Difference: What is the research evidence? Auckland: Australian Council for Educational Research.

Hattie, J. (2008). *Visible Learning: A synthesis of over 800 meta-analysis relating to achievment.* New York: Routledge.

Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research, 77*(1), 81-112.

Heitink, M., Kleij, F. V., Veldkamp, B., Schildkamp, K., & Kippers, W. (2016). A systematic review of prerequisites for implementing assessment for learning in classroom practice. *Educational Research Review 17*, 50-62.

Heyneman, S., Stern, J., & Smith, T. (2012). *The search for effective EFA policies: The role of private schools for low-income children.* Washington: USAID.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement. *American Educational Research Journal, 42*(2), 371-406.

Hopkins, D., & Ahtaridou, E. (2014). *A teacher's guide to classroom observation* (Fourth ed.). Berkshire: Open University Press McGraw-Hill.

Hunter, R., & Hunter, M. (2004). *Madeline Hunter's Mastery teaching : increasing instructional effectiveness in elementary and secondary schools.* California: Corwin Press.

Husbands, C., & Pearce, J. (2012). *What makes great pedagogy? Nine claims from research.*

James, M., & Pollard, A. (2011). TLRP's ten principles for effective pedagogy: rationale, development, evidence, argument and impact. *Research Papers in Education, 26*(3), 275-328.

Jones, L., & Somekh, B. (2005). Observation. In B. Somekh, & C. Lewin, *Research methods in the social sciences* (pp. 138-145). London: Sage Publication.

JP Morgan Global Research. (2010). *Impact investment: an emerging asset class.* J.P.Morgan.

J-PAL. (2013). *Improving learning by increasing motivation, targeting instruction, and addressing school governance.* J-PAL.

Kazmi, A. (2007, April 16). Inspection of maintained schools in England, a historical perspective. *Initial Specialist Course: Contemporary Education Policy*. London: UCL IOE.

Khemani, S. (2019). *What is State Capacity?* Washington D.C.: World Bank Group.

Klahrl, D., & Nigam, M. (2004). The Equivalence of Learning Paths in Early Science Instruction: Effects of Direct Instruction and Discovery Learning. *Psychological Science, 15*(10), 661-667.

Knapp, M., Shields, P., & Turnbull, B. (1995). Academic Challenge in High-Poverty Classrooms. *Phi Delta Kappa International, 76*(10), 770-776.

Kremer, M., Nazmul Chaudhury, F., Rogers, H., Muralidharan, K., & Hammer, J. (2005). Teacher Absence in India: A Snapshot. *Journal of the European Economic Association, 3*(2), 658–667.

Kulik, C.-L., Kulik, J., & Bangert-Drowns, R. (1990). Effectiveness of Mastery Learning Programs: A Meta-Analysis. *Review of Educational Research, 60*(2), 265–299.

Kyriakides, L., & Creemers, B. (2009). The effects of teacher factors on different outcomes: Two studies testing the validity of the dynamic model. *Effective Education, 1*(1), 61-85.

LaRocque, N. (2008). *Public-Private Partnerships in Basic Education: An International Review.* Reading: CfBT Education Trust.

Leech, J., & Moon, B. (1999). *Learners and Pedagogy .* London: Sage.

Lewin, C. (2005). Elementary quantitative methods. In B. Somekh, & C. Lewin, *Research methods in social science* (pp. 215-225). London: Sage.

Lin, A. M. (2007). What's the Use of “Triadic Dialogue”?: Activity Theory, Conversation Analysis, and Analysis of Pedagogical Practices. *Pedagogies: An International Journal, 2*(2), 77-94.

Lingard, B. (2007). Pedagogies of Indifference. *International Journal of Inclusive Education, 11*(3), 245-266 .

Masino, S., & Nino-Zarasua, M. (2016). What works to improve the quality of student learning in developing countries? *International Journal of Education Development, 48*, 53-65.

Mcloughlin, C. (2013). *Low cost private schools: evidence, approaches and emerging issues.* Birmingham: EPS PEAKS Economics and private sector - Professional evidence and applied knowledge services.

Midgeley, W., Danaher, P. A., & Baguley, M. (2013). *The role of participants in education research: Ethics, epistemologies, and methods.* London: Routledge.

Mohyuddin, R. G., & Khalil, U. (2016). Misconceptions of Students in Learning Mathematics at Primary Level. *Bulleting of Education and Research, 38*(1), 133-162.

Mourshed, M., Chijioke, C., & Barber, M. (2010). *How the world's most improved education system keep getting better.* Mckinsey.

Muijs, D. (2012). Methodological changes in school effectiveness research. In C. Chapman, P. Armstrong, A. Harris, D. Muijs, D. Reynolds, & P. Sammons, *School effectiveness and improvement research, policy and practice: challenging the orthodoxy* (pp. 58-68). London: Routledge.

Muijs, D., Kyriakides, L., Werf, G. v., Creemers, B., Timperley, H., & Earl, L. (2014). State of the Art - Teacher Effectiveness and Professional Learning. *School Effectiveness and School Improvement: An International Journal of Research, Policy and Practice, 25*(2), 231-56.

Muijs, R. D. (2010). Changing classroom practice. In D. Hargreaves, A. Lieberman, M. Fullan, & D. Hopkins (Eds.), *Second International Handbook of Educational Change* (pp. 857-68). London: Springer.

Muralidharan, K., & Sundararaman, V. (2015, August). The aggregate effect of school choice: evidence from a two-stage experiment in India. *The quarterly journal of economics, 130*(3).

Murata, A. (2015). Interactions between Teaching and Learning Mathematics in Elmentary Classrooms. In *The SAGE Handbook of Learning* (pp. 233-242). London: SAGE Publications.

Nag, S., Chiat, S., Torgerson, C., & Snowling, M. J. (2014). *Literacy, Foundation Learning and Assessment in Developing Countries.* London: Department for International Development.

Noble, H., & Smith, J. (2017). *Issues of validity and reliability in qualitative research*. Retrieved from British Medical Journal: http://ebn.bmj.com/content/18/2/34#ref-4

OPM. (2012). EFS inception note. (O. P. Management, Ed.) Unpublished.

OPM. (2015a). EFS baseline data. Oxford.

OPM. (2015b). *Education Fund for Sindh Impact Evaluation Baseline Report.* Oxford: Oxford Policy Management.

Orr, D., Westbrook, J., Pryor, J., Durrani, N., Sebba, J., & Adu-Yeboah, C. (2013). *What are the impacts and cost-effectiveness of strategies to improve performance of untrained and under-trained teachers in the classroom in developing countries?* London: EPPI Centre.

Pakistan Bureau of Statistics. (2012). *Pakistan social and living standards measurement*. Retrieved October 18, 2013, from PSLM 2012: http://www.pbs.gov.pk/content/pakistan-social-and-living-standards-measurement

Palardy, G. J., & Rumberger, R. W. (2008). Teacher effectiveness in the first grade: the importance of background qualifications, attitudes and instructional practices for student learning. *Educational Evaluation and Policy Research*, 111-140.

Patrinos, H. (2012). *School vouchers can help improve education systems.* Retrieved from WISE.

Patrinos, H., Barrera-Osorio, F., & Guaqueta, J. (2009). *The role and impact of public-private partnerships in education.* Washington: The World Bank.

Pianta, R. C., La Paro, K. M., & Hamre, B. K. (2008). *Classroom assessment scoring system.* Baltimore:: Paul H. Brookes.

Piper, B., Ralaingita, W., Akach, L., & King, S. (2016). Improving procedural and conceptual mathematics outcomes: evidence from a randomised controlled trial in Kenya. *Journal of Development Effectiveness, 8*(3), 404-422.

Piper, B., Zuilkowski, S. S., Dubeck, M., Jepkemei, E., & King, S. J. (2018). Identifying the essential ingredients to literacy and numeracy improvement: Teacher professional development and coaching, student textbooks, and structured teachers' guides. *World Development, 106*, 324-336.

Pouezevara, S., Pflepsen, A., Nordstrum, L., King, S., & Gove, A. (2016). *Measures of quality through classroom observation for the Sustainable Development Goals: Lessons from low-and-middle-income countries.* RTI International.

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

Pritchett, L. (2014). *The risks to education systems from design mismatch and global isomorphism.* Helsinki: World Institute for Development Economics Research.

Pritchett, L. (2015). *Creating Education Systems Coherent for Learning Outcomes: Making the Transition from Schooling to Learning.* London: Research on Improving Systems of Education (RISE).

Pritchett, L., & Banerji, R. (2013). *Schooling is not Education: using assessment to change the politics of non-learning.* Washington DC: Centre for Global Development.

Reubens, A., & Kline, T. (2009). *Pilot of the Early Grade Mathematics Assessment: Final report.* Washington: USAID.

Reynolds, D., Creemers, B., Stringfield, S., & Teddlie, C. (2002). *World Class Schools: International Perspectives on School Effectiveness.* London: RoutledgeFalmer.

Reynolds, D., Hopkins, D., & Stoll, L. (1993). Linking School Effectiveness Knowledge and School Improvement Practice: Towards a Synergy. *School Effectiveness and School Improvement, 4*(1), 37-58.

Reynolds, D., Sammons, P., Fraine, B. D., Townsend, T., & Damme, J. V. (2011). Educational Effectiveness Research (EER): A State of the Art Review. *International Congress for School Effectiveness and Improvement.* Cyprus.

Reynolds, D., Sammons, P., Stoll, L., Barber, M., & Hillman, J. (1996). School Effectiveness and School Improvement in the United Kingdom. *School Effectiveness and School Improvement , 7*(2), 133-158.

Rincon-Gallardo, S., & Fleisch, B. (2016). Bringing effective instructional practice to scale: An introduction. *Journal of Education Change, 17*, 379-383.

Rosenshine, B. (2009). The Empirical Support for Direct Instruction. In S. Tobias, & T. M. Duffy (Eds.), *Constructivist Instruction: Success or Failure?* (pp. 201-220). New York: Routledge.

Rosenshine, B. (2012). Principles of Instruction Research based strategies that all teachers should know. *American Educator*. doi:https://na01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fteacherhead.com%2F2017%2F06%2F03%2Fteaching-and-learning-research-summaries-a-collection-for-easy-access%2F&data=02%7C01%7Casyia.kazmi%40gatesfoundation.org%7Cc01b46775afc42e2f93208d662b

Rossiter, J., Woodhead, M., Rolleston, C., & Moore, R. (2018). *Delivering on every child's right to basic skills.* Oxford: Young Lives.

Rowland, T., Turner, F., Thwaites, A., & Huckstep, P. (2009). Knowledge for Teaching Mathematics: Introducing the Knowledge Quartet Framework. In *Developing Primary Mathematics Teaching: Reflecting on Practice with the Knowledge Quartet* (pp. 18-40). London: SAGE.

RTI International. (2016). *Nigeria Reading and Access Research Activity (RARA): Results of an approach to improve early grade reading in Hausa in Bauchi and Sokoto States. USAID, Abuja, Nigeria.* Abuha: RTI. Retrieved from https://www.eddataglobal.org/countries/index

Saeed, M., & Mahmood, K. (2002). Assessing competency of Pakistani primary school teachers in mathematics, science and pedagogy. *International Journal of Educational Management, 16*(4), 190-195.

Sammons, P. (2012). Methodological issues and new trends in educational effectiveness research. In C. Chapman, P. Armstrong, A. Harris, D. Mujis, D. Reynolds, & P. Sammons, *School Effectiveness and improvement Research, Policy and Practice* (pp. 9 - 26). Oxford: Routledge.

Sandefur, J. (2012, July 25). *Waiting for superman in Lahore. Do poor people need private schools*. Retrieved January 20, 2013, from From poverty to power: http://www.oxfamblogs.org/fp2p/?p=11047

Shalem, Y., Clercq, F. D., Steinber, C., Steinberg, & Koornhof, H. (2018). Teacher autonomy in times of standardised lesson plans: The case of a Primary School Language and Mathematics Intervention in South Africa. *Journal of Education Change (2018).* . Retrieved from https://doi.org/10.1007/s10833-018-9318-3

Shayer, M. (2003). Not just Paiget; not just Vygotsky, and certainly not Vygotsky as alternative to Piaget. *Learning and Instruction, 13*, 465-485.

Shiraz, M., & Qaisar, S. (2017). Mathematics Teachers' Beliefs and their Practices towards Collaborative Learning in Public and Private Schools: A Comparative Case Study. *Journal of Educational Research, 20*(2), 95-114.

Shulman, L. (1986). Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher, 15*(2), 4-14.

Shulman, L. (1987). Knowledge and Teaching: Foundations of the New Reform. *Harvard Educational Review, 67*(1), 1-22.

Sinclair, J., & Coulthard, R. M. (1975). *Towards an analysis of discourse.* London:: Oxford University Press.

Singh, R., & Sarkar, S. (2012). *Teaching quality counts: How student outcomes relate to quality of teaching in private and public schools in India.* London: Young lives.

Smith, F., Hardman, F., & Tooley, J. (2005). Classroom interaction in pricate schools schools serving low-income families in Hyderabad, India. *International Education Journal, 6*(5), 607-618.

Snilstveit, B., Stevenson, J., Menon, R., Phillips, D., Gallagher, E., Geleen, M., . . . Jimenez, E. (2016). *The impact of education programmes on learning and*

school participation in low- and middle-income countries. London: International Initiative for Impact Evaluation.

Sockett, H. (1993). *The moral base for teacher professionalism.* New York: Teachers College Press.

Somekh, B. (2005). Educational research. In B. Somekh, & C. Lewin, *Research methods in the social sciences* (pp. 33-40). London: Sage Publication.

Stahl, R. J. (1994, May). Using "Think-Time" and "Wait-Time" Skillfully in the Classroom. Virginia.

Stark, S., & Torrance, H. (2005). Case study. In B. Somekh, & C. Lewin, *Research methods in the social sciences* (pp. 33-40). London: Sage publication.

Stoll, L., & Fink, D. (1996). *Changing our schools.* Suffolk: Open University Press.

Stronge, J. H., Ward, T. J., Tucker, P. D., & Hindman, J. L. (2007). What is the relationship between teacher quality and student achievement? An exploratory study. *Journal of Personnel Evaluation in Education, 20*(4), 165–84.

Sweller, J., Merrienboer, J. V., & Paas, F. (1998). Cognitive Architecture and Instructional Design. *Educational Psychology Review, 10*(3), 251-296.

Tayyaba, S. (2012). Rural-urban gaps in academic achievement, schooling conditions,. *International Journal of Educational, 26*(1), 6-26.

The Economist. (2015, August 1). *Learning unleashed: Low-cost private schools*. Retrieved March 21, 2017, from The Economist: http://www.economist.com/news/briefing/21660063-where-governments-are-failing-provide-youngsters-decent-education-private-sector

The Economist. (2015, August). Low cost private schools: Learning unleashed. *The Economist*.

Thomas, S. M., Salim, M. M., Munoz-Chereau, B., & Peng, W.-J. (2012). Educational quality, effectiveness and evaluation: perspectives from China,

South America and Africa. In C. Chapman, P. Armstrong, A. Harris, D. Muijs, D. Reynolds, & P. Sammons, *School effectiveness and improvement research, policy and practice: challenging the orthodoxy* (pp. 125-145). London: Routledge.

Tichenor, M. S., & Tichenor, J. M. (2004). Understanding Teachers' Perspectives on Professionalism. *The Professional Educator, 28*, 89-95.

Timperley, H., Wilson, A., Barrar, H., & Fung, I. (2007). *Teacher Professional Learning and Development.* Wellington: Crown.

Tredoux, C., & Dawes, A. (2018). *Predictors of Mathematics and Literacy Skills at 15 Years Old in Ethiopia, India, Peru and Vietnam: A longitudinal Study.* London: Young Lives.

UNESCO. (2005). *Education for All Global Monitoring Report: The quality imperative.* Paris: UNESCO.

UNESCO. (2012, October). *Education for All Global Monitoring Report - Education in Pakistan.* Retrieved from UNESCO: http://en.unesco.org/gem-report/sites/gem-report/files/EDUCATION_IN_PAKISTAN__A_FACT_SHEET.pdf

UNESCO. (2015). *Education for All*. Retrieved August 26, 2015, from Global Education Monitoring Report: http://en.unesco.org/gem-report/sites/gem-report/files/2015_report_dataviz/index.html

UNESCO. (2016). *Leaving no one behind: How far on the way to universal primary and secondary education?* UNESCO. Retrieved from http://uis.unesco.org/sites/default/files/documents/fs37-leaving-no-one-behind-how-far-on-the-way-to-universal-primary-and-secondary-education-2016-en.pdf

UNESCO. (2016). *The world needs almost 69 million new teachers to reach the 2030 education goals.* UNESCO Institute of Statistics.

Unterhalter, E. (2015). In T. McCowan, & E. Unterhalter (Eds.), *Education and International Development: An Introduction* (pp. 127-149). London: Bloomsbury.

Vignoles, A., Jerrim, J., & Cowan, R. (2015). *Mathematics Mastery: Primary Evaluation Report.* London: Education Endowment Foundation.

Vygotsky. (1986). *Thought and language.* Camrbidge: MIT press.

Walliman, N. (2011). *Research Methods The Basics.* London: Routledge.

Waring, M., & Evans, C. (2014). *Understanding Pedagogy : Developing a critical approach to teaching and learning.* Taylor and Francis.

Wassermann, S. (2015). What is teaching? Inside the balckbox of what teachers do. *Childhood education*, 83-89.

Watkins, C., & Mortimore, P. (1999). Pedagogy: What Do We Know? In P. Mortimore (Ed.), *Understanding pedagogy and its impact on learning* (pp. 1-19). Somerset: SAGE.

Watkins, K. (2012, July 26). *Holding out for the super voucher: Kevin Watkins responds to Justin Sandefur on private versus public education*. Retrieved January 20, 2013, from From poverty to power: http://www.oxfamblogs.org/fp2p/?tag=kevin-watkins

Westbrook, J., Durrani, N., Brown, R., Orr, D., Pryor, J., Boddy, J., & Salvi, F. (2013). *Pedagogy, curriculum, teaching practices and teacher education in developing countries: Education rigorous literature review.* University of Sussex. Department for International Development UKaid.

Wiliam, D. (2011). What is assessment for learning? *Studies in Education Evaluation*, 3-14.

Wilson, E. (2013). *School-based Research A guide for education students.* London: Sage Publication.

Woods, P. (1996). *Researching the Art of Teaching: ethnography for educational use.* London: Routledge.

World Bank. (2012). *Pakistan: can low cost private schools improve learning?* Retrieved from

http://documents.worldbank.org/curated/en/2012/12/16875629/pakistan-can-low-cost-private-schools-improve-learning

World Bank. (2017). *World Development Report 2018: Learning to realize education's promise.* Washington D.C.: World Bank.

World Bank. (2018a). Human Capital Project. Washington DC: World Bank. Retrieved from http://www.worldbank.org/en/publication/human-capital#Data

World Bank. (2018b). *New country classifications by income level: 2018-2019*. Retrieved February 26, 2019, from https://blogs.worldbank.org/opendata/new-country-classifications-income-level-2018-2019

World Bank. (2018c). *Learning to realie education's promise.* Washington: The World Bank Group.

World Population Review. (2016, October 26). *Karachi population 2016*. Retrieved December 25, 2016, from World population review: http://worldpopulationreview.com/world-cities/karachi-population/

Wragg, E. (1999). *An introduction to classroom observation.* London: Routledge.

Wragg, E. (2002). Interviewing. In M. Coleman, & A. R. Briggs, *Methods in Educational Leadership and Management* (p. 297). London: Sage.

Yin, R. K. (2009). *Case Study Research: Design and Methods* (4 ed., Vol. 5). London: Sage Ltd.

Zyngier, D. (2016). Culture and pedagogy(ies): (What) Have We Learned from and Since Alexander 2001. In *The SAGE Handbook of Curriculum, Pedagogy and Assessment: Two Volume Set* (pp. 171-185). London: Sage Publication.

Appendix 1. Pilot-schools contextual information

	Building structure	Environment	Children's appearance	Number of children and fees charged
PS1	School in a converted house in a lower middle-class area.	Clean and tidy but small with about five classes. The walls were painted with giant, colourful cartoons; serving a poor area.	Neatly dressed in uniform	325 fee-paying students paying 600Rs (£3.24) per month Since May 2013, in the afternoon shift there were 90 EFS funded students.
PS2	Large, purpose-built school	A large purpose-built school with over 20 classes serving a poor area.	Neatly dressed in uniform	850 students charged over 900Rs (£4.86) per month and in the afternoon the school had 225 EFS children
PS3	School in a converted house.	Bright and airy school but in a poor area, linked to a British organisation. Unlike the other four schools, S3, as a NGO, would be familiar with working with funding agencies such as DFID.	Neatly dressed, with some in uniform others not.	200 NGO funded children in the morning paying 500Rs (£2.70). In the afternoon the school had 65 EFS children.
PS4 Case-study school B	Large, purpose-built school. Poor lighting and resources in the classrooms	Very poor, dangerous area of Karachi. the principal did not want her interview recorded.	Neatly dressed, in uniform; older students more smartly dressed than younger ones.	900 fee-paying children at 900Rs (£4.86) and in the afternoon it was educating 300 EFS children. The boys were aged 6 to 10 years old but the girls were aged up to 14.
PS5	Purpose built school	Very poor area On its doorstep was a vast rubbish dump	The children were dusty with unwashed hair. They were proud of their uniform and tried to keep it clean.	105 fee-paying children, 48 were EFS The school charged the fee-paying students 300Rs (£1.62) so EFS children were actually worth more at 400Rs (£2.16). The principal said parents didn't know the children's age and felt that they got the children that were too young then couldn't learn fast enough.

Appendix 2. Interview schedule for the in-depth case-study school

- Explain right to refuse to take part in the interview or to answer particular questions
- Explain confidentiality
- Seek permission to record

1. Describe how you came to be a teacher
2. How do you think teachers are viewed in society?
3. Describe the students in your school
4. Describe what you are trying to do with children here
5. Describe a good student-teacher relationship
6. How do you feel about mathematics?
7. Describe a good teacher to me
8. Describe your approach to a mathematics lesson
9. What do you think helps children to learn mathematics?
10. How does the school/headteacher/headquarters help your work or hinder it?

Follow up interesting aspect from the lesson observation

Ask if they were willing to share personal information, such as age, salary, qualification. Stress they did not have to.

Appendix 3. Extract of interview transcripts and notes

Extract of teacher interview transcript from pilot-school1

AK: Before the class starts, how do you know what to teach the children?

T: A day before we prepare the copy [*children's exercise books*] so if we have to do English tomorrow then today we will keep the copies and tell parents that we have the copies. We will firstly prepare then preparing time will be saved.

AK: What do you do in preparing?

T: For example, today I had to do addition so I prepared the children's copy: made a column for addition in their books and wrote the questions in. If I did that in the class the children would have been noisy. My attention would have been in the copies, that I had to prepare them, and it wouldn't have been on the children.

AK: So, you had in advance written the questions in the pupils books?

T: Yes.

AK: So, when you think about what else you have to teach what planning do you do?

T: We have a schedule ready: copy work has to be done, reading has to be done.

AK: Do you ever think which children will find it difficult and which children will find it easy? What do you do for them?

T: We give them extra time so if school ends at 5 o'clock then we will keep them until 5.30 and let the parents know to pick them up after half an hour. If he [*student*] doesn't come today to write he will have to come tomorrow; if he doesn't come tomorrow he will have to come the day after; but is very important that he will have to [*do his work*]

AK: And for those who are going to find it easy?

T: Then we just tell their parents if they are doing well and they may be weak in the future I will just tell the parents that they are getting weak. [*T didn't understand my line of questioning so I left it and moved on]*

AK: When you are in the lesson what do you do to check that pupils have understood or not?

T: Sometimes I ask the children in the middle questions 'tell me what I've just told you' and if they can't tell then I understand they haven't understood.

AK: What else?

T: When I was doing the reading I was listening and thought some were reading and some weren't and some were occupied, playing with pens and things. This way children got sorted and started to listen to each other: whether that pupil was saying it right and can I say it right or whether they were saying it wrong and I can say it right.

AK: And do you know in advance which children are weak?

T: I can tell from the tests which are weak and then I have to look at them specially. There are some children, and we have them in the morning as well, that you have to stand on their heads to make them work. The parents say 'Miss you have to stand on their heads'. While we are standing there they will write, if we move away this stops. There are some children who will be writing properly and they will look at their neighbour and see that they're writing wrong and they will rub their own work out and start writing wrong. So, we have to look at them with the '*full concentration'.*

Extract of teacher interview transcript from school5

AK: What is assessment? [I then explained what it meant] How do you know which children have understood or who hasn't? How do you assess children?

[The teacher was shy]

T: Those who haven't understood I have to explain it to them.

AK: How do you know they haven't understood?

T: I ask who has understood and if they haven't I explain it to them. Children will also say they haven't understood, please explain it, so I explain it to them.

AK: I saw you asked children to do question on the board for timetables – this is good. You ask questions in class, how else do you know they have understood, outside of class?

T: When I do a test if they don't get it I asked them to try it again so they understand.

AK: Do you take tests after every class or sometimes?

T: No, I do tests every time. I teach them the whole subject then I give them a test. [The teacher meant the lesson objective by using the word subject, rather than a medium term or long-term plan]

…

AK: I saw in their books they had a lot of work done and their writing is good. What do you think they have fully understood in mathematics and what they haven't?

T: In maths they haven't understood addition and subtraction. I have asked them to practice so they understand.

AK: You are right, some have understood some haven't understood.

T: When they don't understand I give them more practice to do.

AK: I think they need more practice. You do small tests, like we saw, do you ever do big tests, like after a month?

T: Grand tests, you are saying grand tests?

AK: Each school does something different, what do you do?

T: After every 15 days...what syllabus we have covered we test

AK: What was covered in the last 15 days? Or the whole syllabus?

T: The last 15 days

AK: Do you write the test or does someone else write it?

T: I write it

AK: What do you do with the test results?

T: We give numbers, T2: and we invite parents and tell them about their children

Ak: All parents?

T2: Those who can come: we have children here from the ‘lower classes’. Mothers might be working so they can’t come. Those who can come really [zaroor] come and we talk about the children

AK: Out of 19 children who will come?...half?

T2: Half will definitely come

AK: What kind of discussion will you have with them?

T2: Discussion about children’s test and how the children are going…and things other than studies...such as their cleanliness...how they are coming...uniform…nails…

AK: If you marked the test and five understood really well and five didn’t what will you do with them?

T: I will explain it again to those who didn’t understand

Ak: What will you do with the rest of the class while you are explaining to the five?

T: I explain to everyone [total mila ke sumjhaenge]

AK: What will you do with those who understood really well?

T2: Those who do really well, study well, we sit them next to those who didn’t and ask them to ‘help’ them that way they get more ‘confidence’. This is a way too.

Appendix 4. Component for coding of hierarchical themes used to analyse data

RQ1 Who are the students?	RQ2 What values underpin teachers' instructional and professional practices?	RQ3 What instructional practices do teachers use in mathematics classrooms?	RQ4 How does the institutional environment support (or hinder)?
	RQ 1-4. Teachers' background - Age - Training and education - From locality	**RQ3.1. Lesson planning:** - Use syllabus/textbooks/teacher guides - Regular - Do questions - Research	**RQ3.5 Curriculum plans** - Syllabus - Curriculum coverage - T guides
Student characteristics: - Poor - Illiterate parents - Child labour - Overcrowded housing - First in the family to attend school - Support with academic work at home	**RQ2&3. Ethic of care** - Personal development and well-being of students - Nurture - Love/care - Tarbiyat	**RQ3.2. Classroom environment** - Calm and orderly - Focused on work - Energetic - S response ▪ eager to respond ▪ confident to make mistakes ▪ fearful and intimidated	**RQ3.5** Continuous professional development - Focus on behaviour as well as instruction - Demo-lessons - Headteacher trains T - T train each other - T train themselves ▪ Further study ▪ Research on internet
	RQ1-4 View of students: - Expectation of students - Ambition for students	**RQ3.2. Behaviour management** - S polite, courteous and well-behaved to T, adults, each other - S responsive to T directions/instruction/explanation	**RQ3.5** Provision of resources

		- Fully - Mostly - Sometimes S engaged with tasks: - Fully - Mostly - Sometimes T directions followed: - Frequent/rare - Obeyed/ignored - Verbal/non-verbal	
	1,2&3. Knowledge of students: - academic abilities and gap - barriers they face	**RQ3.2. Rules, routines and rituals** - Rules understood so invisible - Efficient use of class time ▪ Lesson begin and end on time ▪ Giving/collecting resources - Use of lesson time ▪ Fully on learning ▪ Mostly on learning ▪ Mostly not on learning (marking) - Routine ▪ S greeting ▪ Date/topic/children present on board	**RQ3.5** T renumeration package
	Reason for teaching: - Teaching to address financial burden - Profession of choice - Reputation of the school **1&2. Moral purpose**	**RQ3.2 & RQ3.3. Communication** - T speaks/tone of voice is polite - T does not raise voice - Formal language - Respectful interaction with children - S speak politely to T and each other ▪ Teacher ▪ Each other	**RQ3.5** T view of parents: - works with parents - support them - classes for them

	- Religious obligation - Transforming locality - Social obligation		
	-	**RQ3.3. Mathematical communication** - Emphasis on vocabulary ▪ English/Urdu - T gives clear explanations **IRF** - T expects S to give extended answers - Feedback is on: ▪ Task ▪ Process ▪ Self-regulation - Self	**RQ3.**5. T works with policymakers
	After-lesson catch up	**RQ3.3. Lesson framing** - Reviews past lesson/homework - Articulates lesson objectives - Links to other mathematics/subjects **Lesson end** ▪ Recap ▪ walkout	**RQ3.5.** What makes a good T? T character
		RQ3.3. Direct instruction & scaffolding - T develops conceptual understanding and meaning-making - T's modelling and explanation - T mathematises S lives; uses real-life examples - T questions to check for understanding - T takes side-turns in response to q	

		- T uses resources to aid understanding - Cognitive demand of task ▪ Demanding/multi-method multiple solution ▪ Low level repetitive task (rote) ▪ T anticipates common errors and misconceptions and explicitly addresses these
	-	**RQ3.3. Guided practice** - T presents worked examples - T questions to check understanding - T paces teaching to match understanding - T monitors S as they work - T talks to individuals - T spots errors and addresses them - T interrupts seatwork to provide teaching
	-	**RQ3.3. Formative assessment & Questioning** - Open/closed - Single answer/extended answer - S asking Q
		RQ3.4 Independent practice - In-class - Homework - Quality of written feedback to S
		RQ3.4. Summative assessment - Weekly/monthly/annual assessment - Assessment used to plan teaching - Assessment used to plan training - Assessment used to plan remedial classes

Appendix 5. Differences between novice and expert instructional practices

Teaching practice	Teachers with expert practices	Teachers with novice practices
Classroom environment	T plans academically demanding work Class atmosphere is relaxed, focused and with energy S confident to make mistakes	T sets mundane low-level repetitive work Class atmosphere lacks energy S are intimidated or fearful
Nurturing environment Behaviour	S highly responsive to teacher instructions Few occasions needed to reprimand S as T's expectations/rules are well understood and adhered to Mathematics learning time maximised in lesson with very efficient use of time e.g. when transitioning S are on-task for the work set by the T or concentrating when T explaining	T has to repeat instructions as S do not respond T raise their voice in anger S don't pay attention to the teacher exposition Time spent on non-mathematical tasks, including marking There is insufficient work for S to do
Lesson framing	T states the key objective of the lesson, revises key vocabulary T makes link to previous and next lesson T makes link to other subjects	T writes date and subject on the board
Communication/developing mathematical literacy	T emphasises mathematical notation, vocabulary and presentation, translated and used in discussion T asks questions to check understanding and engages in dialogue; questions require S to think and give extended answers, showing mathematical reasoning and explain their answers T provides opportunities for S led discussion	T is transmissive, T asks questions and answers herself T asks questions that require one-word, low-level recall answers Key vocabulary is not made explicit to S

Developing conceptual understanding Scaffolding and modelling Guided practice Use of resources	T structures explanations clearly to aid understanding T's presentation helps S with 'meaning-making', linking parts to the whole T present problems that develop S advance thinking skills, are appropriately complex and non-routine T presents worked examples in increasing complexity to challenge S T paces teaching to match understanding T uses resources to aid understanding and enjoyment T uses interesting real-life examples to make mathematics relevant T 'mathematicise' S lives and bring it to the classroom	T tightly controls the instruction limiting opportunity for S thinking T teaches processes rather than understanding T presents routine, repetitive questions for S to solve without progression in complexity T provides insufficient opportunity for S to practice mathematics T follows the curriculum rather than S level T does not use resources to aid understanding Mathematics is not related to real life
Formative assessment Questioning, using errors	T monitors S as they work in class T questions regularly to check for understanding T spots conceptual errors and addresses them in lesson T provides opportunity for S to ask questions T adapts teaching to meet the needs of S differing needs Feedback is on task, process and self-regulation	T marks individuals work in lesson T's questioning does not check for understanding T does not identify errors or seek to address them Feedback is on self
Independent and summative assessment Homework	Marking is formative, learning orientated and helps S learn System supports teachers to provide additional teaching for those who need it	Marking and summative assessment is performance orientated

Appendix 6. Information and consent form

Informed Consent Form Doctorate of Education dissertation research

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Project Title: Teaching and learning in low cost private schools in Karachi

Researcher: Asyia Kazmi

Thank you for your interest in taking part in this research. Before you agree to take part, the person organising the research must explain the project to you.

If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you to decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

Participant's Statement

I agree that:

- I have read the notes written above and the Information Sheet and understand what the study involves.
- I understand that if I decide at any time that I no longer wish to take part in this project, I can notify the researchers involved and withdraw immediately.
- I consent to the processing of my personal information for the purposes of this research study.
- I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.
- I agree that the research project named above has been explained to me to my satisfaction and I agree to take part in this study.

I understand that my participation will be taped, if I give permission, and I consent to use of this material as part of the project.

Signature: Date:

Teaching and learning in low cost private schools in Karachi Information Sheet

I am undertaking a Doctorate in Education at the University College London, Institute of Education (UCL IOE) in England where I am a student.

My research explores how teachers in low cost private schools in Karachi practice and understand teaching and learning in mathematics. My research will be written up in a thesis for examination by UCL IOE. The intention of my research is to help policymakers understand what teaching and learning in mathematics is like and how they can improve it.

As part of my research I will be observing mathematics lessons and interviewing teachers and principals. I will spend a week in your school and would like to seek your permission to interview you and observe two to three lessons you may be teaching.

I will treat everything you say as confidential and will not identify your name or the name of the school in my thesis. I will collate the responses of everyone I interview and the lessons I observe and summarise them in my thesis. In my thesis you will not be able to identify who said what or which schools I visited.

Interviews

By the end of the research I will have interviewed about 20 teachers. During interviews I will ask you about your students and their backgrounds, what it is like to be a teacher, what is it like to be a mathematics teacher and how do you prepare to teach your lessons.

I will also ask some personal information such as your name, age, qualification and experience as this will give me information on who works in schools like yours but I will not use this information to identify you. I will summarise the overall picture so no one is identifiable from this information.

If you give me permission I will tape the interview so that I can study it later. This tape will not be made public and I will delete it after my thesis is submitted

in July 2019. If you do not give me permission to tape I will record in my notebook.

Lesson observations

By the end of the research I will have observed about 30 lessons. In lesson observations, I will sit at the back of your lessons and observe what you do and what your students do and write this down in my note book. If you give me permission I will tape parts of your lesson so that I can study it later. I will delete this tape in July 2018. If it does not disturb your lesson I may also talk to some students.

Please feel free to ask me any questions you like about my research. If at any time you want to stop the interview or the observation, please tell me. This will not be a problem at all.

When my research is finished I will share the summary of it with you by email and will share the link to the final thesis. I thank you sincerely for taking part in my research.

Asyia Kazmi, November 2018

Appendix 7. SPSS outputs of quantitative analysis in chapter 4

Below are the standard table of descriptive statistics, for each variable presented in Chapter 4: mean, standard deviation for continuous variables, percentages for discrete variables with the sample sizes. This analysis is based on OPM data which I had access to through DFID Pakistan.

7.1 Household treatment status

		Frequency	%	Valid %	Cumulative %
Valid	Control	1233	50.1	50.1	50.1
	Treatment	1228	49.9	49.9	100.0
	Total	2461	100.0	100.0	

7.2 Child gender

		Frequency	%	Valid %	Cumulative %
Valid	1	2582	54.0	54.0	54.0
	2	2203	46.0	46.0	100.0
	Total	4785	100.0	100.0	

7.3 Sample population by Union Council

		Frequency	%	Valid %	Cumulative %
Valid	Banars Colony	150	6.1	6.1	6.1
	Chanesar Goth	148	6.0	6.0	12.1
	dakkhana	49	2.0	2.0	14.1
	ESSA NAGRI	222	9.0	9.0	23.1
	Frontier Colony	59	2.4	2.4	25.5
	Godhra Colony	34	1.4	1.4	26.9
	Gulzar Colony	82	3.3	3.3	30.2
	hyderi	166	6.7	6.7	37.0
	Islam Nagar	266	10.8	10.8	47.8
	Islamia Colony	239	9.7	9.7	57.5
	Jamali Colony	16	.7	.7	58.1
	Kalyana	54	2.2	2.2	60.3
	KHAMISO GOTH	263	10.7	10.7	71.0
	Madina Colony	78	3.2	3.2	74.2
	MOHAMMAD NAGAR	258	10.5	10.5	84.7
	Mustafa Colony	35	1.4	1.4	86.1
	Qasba Colony	178	7.2	7.2	93.3
	Qasimabad	27	1.1	1.1	94.4
	Quaidabad	70	2.8	2.8	97.3
	Shahnawaz Bhutto Colony	67	2.7	2.7	100.0
	Total	2461	100.0	100.0	

7.4 HE 16: Household size[a]

		Frequency	%	Valid %	Cumulative %
Valid	1	1	.0	.0	.0
	2	3	.1	.1	.2
	3	60	2.4	2.4	2.6
	4	196	8.0	8.0	10.6
	5	365	14.8	14.9	25.5
	6	433	17.6	17.7	43.2

	7	376	15.3	15.3	58.5
	8	278	11.3	11.3	69.8
	9	210	8.5	8.6	78.4
	10	126	5.1	5.1	83.6
	11	99	4.0	4.0	87.6
	12	58	2.4	2.4	90.0
	13	53	2.2	2.2	92.1
	14	42	1.7	1.7	93.8
	15	31	1.3	1.3	95.1
	16	35	1.4	1.4	96.5
	17	12	.5	.5	97.0
	18	13	.5	.5	97.6
	19	13	.5	.5	98.1
	20	10	.4	.4	98.5
	21	5	.2	.2	98.7
	22	6	.2	.2	98.9
	23	5	.2	.2	99.1
	24	3	.1	.1	99.3
	25	1	.0	.0	99.3
	26	1	.0	.0	99.3
	27	4	.2	.2	99.5
	28	1	.0	.0	99.6
	29	1	.0	.0	99.6
	30	2	.1	.1	99.7
	32	3	.1	.1	99.8
	34	2	.1	.1	99.9
	35	1	.0	.0	99.9
	36	1	.0	.0	100.0
	39	1	.0	.0	100.0
	Total	2451	99.6	100.0	
Missing	System	10	.4		
Total		2461	100.0		

Statistics[a]

HE 16: HHD size

N	Valid	2451
	Missing	10
Mean		7.89
Median		7.00
Std. Deviation		3.933
Range		38
Minimum		1
Maximum		39

7.5 HE 17: Household members less than 18 years old[a]

		Frequency	%	Valid %	Cumulative %
Valid	0	18	.7	.7	.7
	1	114	4.6	4.7	5.4
	2	320	13.0	13.1	18.4
	3	500	20.3	20.4	38.9
	4	545	22.1	22.2	61.1
	5	380	15.4	15.5	76.6
	6	259	10.5	10.6	87.2

	7	142	5.8	5.8	93.0
	8	66	2.7	2.7	95.7
	9	44	1.8	1.8	97.5
	10	14	.6	.6	98.0
	11	19	.8	.8	98.8
	12	5	.2	.2	99.0
	13	7	.3	.3	99.3
	14	7	.3	.3	99.6
	15	3	.1	.1	99.7
	16	2	.1	.1	99.8
	18	1	.0	.0	99.8
	20	1	.0	.0	99.9
	22	1	.0	.0	99.9
	23	1	.0	.0	100.0
	24	1	.0	.0	100.0
	Total	2450	99.6	100.0	
Missing	System	11	.4		
Total		2461	100.0		

a. Evidence of data errors- 18 households with no children were interviewed.

Statistics[a]

HE 17: Members Less than 18

N	Valid	2450
	Missing	11
Mean		4.32
Median		4.00
Std. Deviation		2.295
Range		24
Minimum		0
Maximum		24

7.6 HE 20:Member in the household between 5-16 in school[a]

		Frequency	%	Valid %	Cumulative %
Valid	0	829	33.7	35.5	35.5
	1	499	20.3	21.4	56.8
	2	453	18.4	19.4	76.2
	3	317	12.9	13.6	89.8
	4	141	5.7	6.0	95.8
	5	59	2.4	2.5	98.3
	6	18	.7	.8	99.1
	7	8	.3	.3	99.4
	8	8	.3	.3	99.8
	9	2	.1	.1	99.9
	11	1	.0	.0	99.9
	12	1	.0	.0	100.0
	86	1	.0	.0	100.0
	Total	2337	95.0	100.0	
Missing	System	124	5.0		
Total		2461	100.0		

7.7 Ethnicity of household head[a]

		Frequency	%	Valid %	Cumulative %
Valid	Urdu Speaking	713	29.0	29.1	29.1
	Punjabi	235	9.5	9.6	38.7
	Sindhi	153	6.2	6.2	44.9

	Pathan	885	36.0	36.1	81.1
	Baloch	138	5.6	5.6	86.7
	Kashmiri	9	.4	.4	87.1
	Saraiki	107	4.3	4.4	91.4
	Others	210	8.5	8.6	100.0
	Total	2450	99.6	100.0	
Missing	System	11	.4		
Total		2461	100.0		

7.8 HE 21: Head of household's Education[a]

		Frequency	%	Valid %	Cumulative %
Valid	Less than class 1	219	8.9	8.9	8.9
	Class 1	48	2.0	2.0	10.9
	Class 2	94	3.8	3.8	14.7
	Class 3	98	4.0	4.0	18.7
	Class 4	112	4.6	4.6	23.3
	Class 5	246	10.0	10.0	33.3
	Class 6	55	2.2	2.2	35.6
	Class 7	88	3.6	3.6	39.2
	Class 8	197	8.0	8.0	47.2
	Class 9	58	2.4	2.4	49.6
	Class 10 Deeni Grade 2 or Shahadat ul Aama	260	10.6	10.6	60.2
	Class 11	12	.5	.5	60.7
	Class 12 Deeni Grade 4 or Shahadat ul Khasa	67	2.7	2.7	63.4
	Class 13	1	.0	.0	63.5
	BA / B Sc/B.Ed Deeni Grade 6 Or Shahadat ul Aalia	22	.9	.9	64.4
	Post graduate (MA, MSc/M.Ed) Deeni Grade 8 Or Shahadat ul Aalima	8	.3	.3	64.7
	Degree in Law	3	.1	.1	64.8
	M. Phil, Ph. D	1	.0	.0	64.9
	Other	15	.6	.6	65.5
	None	846	34.4	34.5	100.0
	Total	2450	99.6	100.0	
Missing	System	11	.4		
Total		2461	100.0		

7.9 HB01: Parent Can Read

		Frequency	%	Valid %	Cumulative %
Valid	Yes	4784	31.1	54.6	54.6
	No	3980	25.8	45.4	100.0
	Total	8764	56.9	100.0	
Missing	System	6640	43.1		
Total		15404	100.0		

7.10 HC01: Adult Work for pay * Gender Crosstabulation[a]

			Gender		
			Male	Female	Total
HC01: Work for pay	Yes	Count	2726	647	3373
		% within Gender	76.6%	19.4%	48.9%
	No	Count	835	2684	3519
		% within Gender	23.4%	80.6%	51.1%

Total	Count	3561	3331	6892
	% within Gender	100.0%	100.0%	100.0%

7.11 HC03: Adult's Employment status[a]

		Frequency	%	Valid %	Cumulative %
Valid	Employer	67	.4	1.9	1.9
	Self-employed	435	2.8	12.0	13.9
	Employee (outside agriculture)	1199	7.8	33.2	47.1
	Unpaid family helper	86	.6	2.4	49.4
	Casual Labourer	1797	11.7	49.7	99.1
	Owner cultivator	5	.0	.1	99.3
	Share-cropper	5	.0	.1	99.4
	Other agriculture	8	.1	.2	99.6
	Others(Specify)	12	.1	.3	100.0
	Do not know	1	.0	.0	100.0
	Total	3615	23.5	100.0	
Missing	System	11789	76.5		
Total		15404	100.0		

7.12 HC03: Adult's Employment status * Gender Crosstabulation[a]

		Gender	Male	Female	Total
HC03: Employment status	Employer	Count	49	18	67
		% within Gender	1.7%	2.5%	1.9%
	Self-employed	Count	298	137	435
		% within Gender	10.3%	18.8%	12.0%
	Employee (outside agriculture)	Count	998	201	1199
		% within Gender	34.6%	27.6%	33.2%
	Unpaid family helper	Count	32	54	86
		% within Gender	1.1%	7.4%	2.4%
	Casual Labourer	Count	1490	307	1797
		% within Gender	51.6%	42.1%	49.7%
	Owner cultivator	Count	3	2	5
		% within Gender	0.1%	0.3%	0.1%
	Share-cropper	Count	5	0	5
		% within Gender	0.2%	0.0%	0.1%
	Other agriculture	Count	4	4	8
		% within Gender	0.1%	0.5%	0.2%
	Others(Specify)	Count	6	6	12
		% within Gender	0.2%	0.8%	0.3%
	Do not know	Count	1	0	1
		% within Gender	0.0%	0.0%	0.0%
Total		Count	2886	729	3615
		% within Gender	100.0%	100.0%	100.0%

7.13 HE02: House ownership Status[a]

		Frequency	%	Valid %	Cumulative %
Valid	Owned	1355	55.1	55.2	55.2
	Rented	958	38.9	39.0	94.3
	Rent free	130	5.3	5.3	99.6
	Others	11	.4	.4	100.0
	Total	2454	99.7	100.0	
Missing	System	7	.3		

Total		2461	100.0		

7.14 HE1: Rooms in the house[a]

		Frequency	%	Valid %	Cumulative %
Valid	0	5	.2	.2	.2
	1	1332	54.1	54.3	54.5
	2	744	30.2	30.3	84.8
	3	244	9.9	9.9	94.7
	4	84	3.4	3.4	98.2
	5	25	1.0	1.0	99.2
	6	16	.7	.7	99.8
	7	2	.1	.1	99.9
	8	1	.0	.0	100.0
	11	1	.0	.0	100.0
	Total	2454	99.7	100.0	
Missing	System	7	.3		
Total		2461	100.0		

7.15 HE12J: Household has a TV[a]

		Frequency	%	Valid %	Cumulative %
Valid	Yes	1681	68.3	68.5	68.5
	No	772	31.4	31.5	100.0
	Total	2453	99.7	100.0	
Missing	System	8	.3		
Total		2461	100.0		

Statistics for ‘CC’ relates to children (not just household) so N=4785 in number

Statistics[a]

		CC04A: Printed media	CC04A2: Access to Printed media	CC04B: Radio/ CD/Cassette	CC04B2: Access to Radio/ CD/Cassette	CC04C: TV/VCR/VCD	CC04C2: Access to TV/VCR/VCD	CC04E: Computer	CC04E2: Access to Computer
N	Valid	4777	766	4777	193	4777	3205	4777	93
	Missing	8	4019	8	4592	8	1580	8	4692
Mean		1.84	1.24	1.96	1.38	1.33	1.06	1.98	1.39
Std. Deviation		.367	.428	.197	.486	.470	.240	.138	.490

7.16 CC04A: Printed media[a]

		Frequency	%	Valid %	Cumulative %
Valid	Yes	766	16.0	16.0	16.0
	No	4011	83.8	84.0	100.0
	Total	4777	99.8	100.0	
Missing	System	8	.2		
Total		4785	100.0		

7.17 CC04C2: Access to TV/VCR/VCD

		Frequency	%	Valid %	Cumulative %
Valid	Yes	3009	62.9	93.9	93.9
	No	196	4.1	6.1	100.0
	Total	3205	67.0	100.0	
Missing	System	1580	33.0		
Total		4785	100.0		

7.18 CA08: Child why not enrolled[a]

		Frequency	%	Valid %	Cumulative %
Valid	Too expensive	2081	43.5	68.7	68.7
	Too far away	42	.9	1.4	70.1
	Had to help at home	6	.1	.2	70.3
	Had to help with work	6	.1	.2	70.5
	Parents/elders did not approve	46	1.0	1.5	72.0
	No female staff	1	.0	.0	72.0
	Child sick/handicapped	34	.7	1.1	73.1
	Child too young	534	11.2	17.6	90.8
	Child not willing	143	3.0	4.7	95.5
	Lack of documents	14	.3	.5	95.9
	Education not useful	7	.1	.2	96.2
	Security (conflict)	10	.2	.3	96.5
	Other (specify)	106	2.2	3.5	100.0
	Total	3030	63.3	100.0	
Missing	System	1755	36.7		
Total		4785	100.0		

7.19 HB04: Parent's Reason for never attending school[a]

		Frequency	%	Valid %	Cumulative %
Valid	Too expensive	1237	8.0	35.8	35.8
	Too far away	113	.7	3.3	39.1
	Poor teaching / behaviour	12	.1	.3	39.5
	Had to help at home	102	.7	3.0	42.4
	Had to help with work	199	1.3	5.8	48.2
	Parents/elders did not approve	1004	6.5	29.1	77.3
	No female staff	7	.0	.2	77.5
	No male staff	2	.0	.1	77.5
	Child sick/handicapped	49	.3	1.4	78.9
	Child not willing	430	2.8	12.5	91.4
	Lack of documents	2	.0	.1	91.5
	Education not useful	121	.8	3.5	95.0
	Marriage	8	.1	.2	95.2
	Service (job)	3	.0	.1	95.3
	Security (Conflict)	9	.1	.3	95.5
	Other (specify)	154	1.0	4.5	100.0
	Total	3452	22.4	100.0	
Missing	System	11952	77.6		
Total		15404	100.0		

7.20 Child gender * CA06: Ever been Enrolled Crosstabulation[a]

CA06: Ever been Enrolled			Yes	No	Total
Child gender	1	Count	1549	1030	2579
		% within CA06: Ever been Enrolled	57.5%	49.3%	53.9 %
	2	Count	1144	1058	2202
		% within CA06: Ever been Enrolled	42.5%	50.7%	46.1 %

Total	Count	2693	2088	4781
	% within CA06: Ever been Enrolled	100.0%	100.0%	100.0 %

7.21 Child gender * CA06: Ever been Enrolled Crosstabulation[a]

CA06: Ever been Enrolled			Yes	No	Total
Child gender	1	Count	1549	1030	2579
		% within Child gender	**60.1%**	**39.9%**	100.0%
	2	Count	1144	1058	2202
		% within Child gender	52.0%	48.0%	100.0%
Total		Count	2693	2088	4781
		% within Child gender	**56.3%**	**43.7%**	100.0%

7.22 CB04: Distance to Child's school

		Frequency	%	Valid %	Cumulative %
Valid	Less than 1 km	546	3.5	68.6	68.6
	1- < 2 kms	151	1.0	19.0	87.6
	2 - < 5 kms	24	.2	3.0	90.6
	5 - < 10 kms	1	.0	.1	90.7
	10 kms or more	2	.0	.3	91.0
	Do not know	72	.5	9.0	100.0
	Total	796	5.2	100.0	
Missing	System	14608	94.8		
Total		15404	100.0		

7.23 CE04: Household Chore * Child gender Crosstabulation

			Child gender		Total
			Male	Female	
CE04: Household Chore	Yes	Count	1395	1180	2575
		% within Child gender	61.5%	61.5%	61.5%
	No	Count	875	739	1614
		% within Child gender	38.5%	38.5%	38.5%
Total	Count	2270	1919	4189	
	% within Child gender	100.0%	100.0%	100.0 %	

7.24 Child gender * CE01: Worked Crosstabulation[a]

			CE01: Worked		
			Yes	No	Total
Child gender	1	Count	159	2112	2271
		% within Child gender	7.0%	93.0%	100.0%
	2	Count	95	1824	1919
		% within Child gender	5.0%	95.0%	100.0%
Total		Count	254	3936	4190
		% within Child gender	6.1%	93.9%	100.0%

7.25 Child hours worked Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation
CE03: Hours	158	0	90	15.30	24.413
Valid N (listwise)	158				

a. District = Karachi, Child gender = 1 - boy

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation
CE03: Hours	95	0	80	6.74	13.555
Valid N (listwise)	95				

a. District = Karachi, Child gender = 2 - girl

7.26 Child gender * CE02: Paid/unpaid Crosstabulation[a]

			CE02: Paid/unpaid			
			Paid in Cash	Pain in Kind	Unpaid	Total
Child gender	1	Count	62	5	92	159
		% within CE02: Paid/unpaid	68.9%	83.3%	58.2%	62.6%
	2	Count	28	1	66	95
		% within CE02: Paid/unpaid	31.1%	16.7%	41.8%	37.4%
Total		Count	90	6	158	254
		% within CE02: Paid/unpaid	100.0%	100.0%	100.0%	100.0%

7.27 CB08: Parent Satisfaction with Quality of teacher[a]

		Frequency	%	Valid %	Cumulative %
Valid	Yes	1627	34.0	76.6	76.6
	No	458	9.6	21.6	98.2
	Do not know	38	.8	1.8	100.0
	Total	2123	44.4	100.0	
Missing	System	2662	55.6		
Total		4785	100.0		

7.28 CB10: Parent Overall school's Quality of infrastructure[a]

		Frequency	%	Valid %	Cumulative %
Valid	Yes	1626	34.0	76.6	76.6
	No	446	9.3	21.0	97.6
	Do not know	51	1.1	2.4	100.0
	Total	2123	44.4	100.0	
Missing	System	2662	55.6		
Total		4785	100.0		

7.29 Parent Why not satisfied with the quality of teaching[a]

		Frequency	%	Valid %	Cumulative %
Valid	Poor attendance of teachers in class	178	3.7	36.0	36.0
	Curriculum taught in school is not appropriate	62	1.3	12.5	48.5
	Teachers do not have the right qualifications	105	2.2	21.2	69.7
	Teachers do not know the subject matter well	55	1.1	11.1	80.8
	Teachers do not check homework regularly	23	.5	4.6	85.5
	Children are physically or verbally abused by teachers	7	.1	1.4	86.9
	Other	65	1.4	13.1	100.0
	Total	495	10.3	100.0	
Missing	System	4290	89.7		

Total		4785	100.0		

7.30 Parent Why not satisfied with the quality of teaching[a]

		Frequency	%	Valid %	Cumulative %
Valid	Curriculum taught in school is not appropriate	28	.6	14.9	14.9
	Teachers do not have the right qualifications	47	1.0	25.0	39.9
	Teachers do not know the subject matter well	42	.9	22.3	62.2
	Teachers do not check homework regularly	52	1.1	27.7	89.9
	Children are physically or verbally abused by teachers	10	.2	5.3	95.2
	Other	9	.2	4.8	100.0
	Total	188	3.9	100.0	
Missing	System	4597	96.1		
Total		4785	100.0		

7.31 Parent Why not satisfied with the quality of teaching[a]

		Frequency	%	Valid %	Cumulative %
Valid	Teachers do not have the right qualifications	13	.3	24.5	24.5
	Teachers do not know the subject matter well	13	.3	24.5	49.1
	Teachers do not check homework regularly	20	.4	37.7	86.8
	Children are physically or verbally abused by teachers	6	.1	11.3	98.1
	Other	1	.0	1.9	100.0
	Total	53	1.1	100.0	
Missing	System	4732	98.9		
Total		4785	100.0		

7.32 Parent Why not satisfied with the quality of teaching[a]

		Frequency	%	Valid %	Cumulative %
Valid	Teachers do not know the subject matter well	1	.0	8.3	8.3
	Teachers do not check homework regularly	8	.2	66.7	75.0
	Children are physically or verbally abused by teachers	1	.0	8.3	83.3
	Other	2	.0	16.7	100.0
	Total	12	.3	100.0	
Missing	System	4773	99.7		
Total		4785	100.0		

7.33 CD01: Children Like the most about the school[a]

		Frequency	%	Valid %	Cumulative %
Valid	My teachers teach me well	659	13.8	32.2	32.2
	Teachers there do not beat me	22	.5	1.1	33.3
	Teachers very friendly and helpful	129	2.7	6.3	39.6
	Participating in activities in class	38	.8	1.9	41.5
	Learning useful skills and knowledge	93	1.9	4.5	46.0
	Better prospects for my future	2	.0	.1	46.1
	Feel proud to be in school	9	.2	.4	46.6
	I'm not bullied	1	.0	.0	46.6
	Having time to play	103	2.2	5.0	51.7

	Seeing my friends	115	2.4	5.6	57.3
	Good playground	51	1.1	2.5	59.8
	Good library	2	.0	.1	59.9
	Sports activities	44	.9	2.2	62.0
	School physical environment in general (clean etc)	11	.2	.5	62.6
	Good atmosphere	7	.1	.3	62.9
	Food is very good	25	.5	1.2	64.1
	Lessons are easy to understand	29	.6	1.4	65.6
	Interested in study	385	8.0	18.8	84.4
	Nothing	211	4.4	10.3	94.7
	Others (Specify)	108	2.3	5.3	100.0
	Total	2044	42.7	100.0	
Missing	System	2741	57.3		
Total		4785	100.0		

7.34 CD02: Children Like the Least about the school[a]

		Frequency	%	Valid %	Cumulative %
Valid	Teachers beating us	472	9.9	23.1	23.1
	Teachers or principal shouting at us	47	1.0	2.3	25.4
	Teachers discriminate/are mean to me/pick on me	10	.2	.5	25.9
	Teachers are often not present	16	.3	.8	26.7
	There are not enough teachers	4	.1	.2	26.9
	Teaching is poor	26	.5	1.3	28.1
	Lack of writing materials (pen, paper etc.)	5	.1	.2	28.4
	I cannot help to support my family	2	.0	.1	28.5
	Other children bully me/tease me	158	3.3	7.7	36.2
	I find it hard to understand the language teacher uses	1	.0	.0	36.3
	We don?t learn useful things	6	.1	.3	36.5
	Classroom is noisy	81	1.7	4.0	40.5
	Students fighting	426	8.9	20.8	61.4
	No sports activities	9	.2	.4	61.8
	My uniform is not nice/I don?t have one	3	.1	.1	61.9
	Poor infrastructure/facilities	13	.3	.6	62.6
	School is dirty	47	1.0	2.3	64.9
	No compound wall	1	.0	.0	64.9
	No drinking water tap	19	.4	.9	65.9
	Lack of teaching materials//text books	2	.0	.1	65.9
	Lack of toilets/dirty toilets/no privacy in toilets	20	.4	1.0	66.9
	School is too far away	5	.1	.2	67.2
	Too many students	9	.2	.4	67.6
	Nothing, no problem	500	10.4	24.5	92.1
	Having to sit in class all day long is boring	4	.1	.2	92.3
	I feel ashamed about my performance/am not clever enough	2	.0	.1	92.4
	Others (specify)	156	3.3	7.6	100.0
	Total	2044	42.7	100.0	
Missing	System	2741	57.3		
Total		4785	100.0		

7.35 CD02: Like the Least * Child gender Crosstabulation[a]

		Child gender		
		1 boy	2 girl	Total
Teachers beating us	Count	298	174	472
	% of Total	14.6%	8.5%	23.1%
Teachers or principal shouting at us	Count	22	25	47
	% of Total	1.1%	1.2%	2.3%
Teachers discriminate/are mean to me/pick on me	Count	5	5	10
	% of Total	0.2%	0.2%	0.5%
Teachers are often not present	Count	9	7	16
	% of Total	0.4%	0.3%	0.8%
There are not enough teachers	Count	3	1	4
	% of Total	0.1%	0.0%	0.2%
Teaching is poor	Count	16	10	26
	% of Total	0.8%	0.5%	1.3%
Lack of writing materials (pen, paper etc.)	Count	3	2	5
	% of Total	0.1%	0.1%	0.2%
I cannot help to support my family	Count	2	0	2
	% of Total	0.1%	0.0%	0.1%
Other children bully me/tease me	Count	94	64	158
	% of Total	4.6%	3.1%	7.7%
I find it hard to understand the language teacher uses	Count	0	1	1
	% of Total	0.0%	0.0%	0.0%
We don?t learn useful things	Count	4	2	6
	% of Total	0.2%	0.1%	0.3%
Classroom is noisy	Count	46	35	81
	% of Total	2.3%	1.7%	4.0%
Students fighting	Count	240	186	426
	% of Total	11.7%	9.1%	20.8%
No sports activities	Count	8	1	9
	% of Total	0.4%	0.0%	0.4%
My uniform is not nice/I don?t have one	Count	1	2	3
	% of Total	0.0%	0.1%	0.1%
Poor infrastructure/facilities	Count	5	8	13
	% of Total	0.2%	0.4%	0.6%
School is dirty	Count	21	26	47
	% of Total	1.0%	1.3%	2.3%
No compound wall	Count	0	1	1
	% of Total	0.0%	0.0%	0.0%
No drinking water tap	Count	8	11	19
	% of Total	0.4%	0.5%	0.9%
Lack of teaching materials//text books	Count	1	1	2
	% of Total	0.0%	0.0%	0.1%
Lack of toilets/dirty toilets/no privacy in toilets	Count	10	10	20
	% of Total	0.5%	0.5%	1.0%
School is too far away	Count	3	2	5
	% of Total	0.1%	0.1%	0.2%
Too many students	Count	5	4	9
	% of Total	0.2%	0.2%	0.4%
Nothing, no problem	Count	285	215	500
	% of Total	13.9%	10.5%	24.5%
Having to sit in class all day long is	Count	3	1	4

boring	% of Total	0.1%	0.0%	0.2%
I feel ashamed about my performance/am not clever enough	Count	1	1	2
	% of Total	0.0%	0.0%	0.1%
Others (specify)	Count	86	70	156
	% of Total	4.2%	3.4%	7.6%
Total	Count	1179	865	2044
	% of Total	57.7%	42.3%	100.0%

7.36 *CD01: Like the most Crosstabulation with CA13: Type of school

	Like the most	My teachers teach me well	Teachers there do not beat me	Teachers very friendly and helpful	Participating in activities in class	Learning useful skills and knowledge	Better prospects for my future	Feel proud to be in school	I?m not bullied	Having time to play	Seeing my friends	Good play ground	Good library	Sports activities	School physical environment in general (clean etc)	Good atmo sphere	Food is very good	Lessons are easy to understand	Interested in study	Nothing	Others (Specify)	
Government (Urdu Medium)	Count	123	8	26	13	25	1	1	0	32	32	11	0	7	4	2	6	4	89	46	18	448
	% within CD01:	18.7%	36.4%	20.2%	34.2%	26.9%	50.0%	11.1%	0.0%	31.1%	27.8%	21.6%	0.0%	15.9%	36.4%	28.6%	24.0%	13.8%	23.1%	21.8%	16.7%	21.9%
Government (English Medium)	Count	11	0	1	1	2	0	0	0	2	2	2	0	2	0	0	0	0	1	8	3	35
	% within CD01:	1.7%	0.0%	0.8%	2.6%	2.2%	0.0%	0.0%	0.0%	1.9%	1.7%	3.9%	0.0%	4.5%	0.0%	0.0%	0.0%	0.0%	0.3%	3.8%	2.8%	1.7%
Government (Sindhi)	Count	4	1	4	0	0	0	1	0	1	3	1	0	2	0	0	0	0	7	1	0	25
	% within CD01:	0.6%	4.5%	3.1%	0.0%	0.0%	0.0%	11.1%	0.0%	1.0%	2.6%	2.0%	0.0%	4.5%	0.0%	0.0%	0.0%	0.0%	1.8%	0.5%	0.0%	1.2%
Private (Urdu Medium)	Count	143	5	28	8	18	1	2	0	20	27	11	1	5	3	2	7	3	85	48	25	442
	% within CD01:	21.7%	22.7%	21.7%	21.1%	19.4%	50.0%	22.2%	0.0%	19.4%	23.5%	21.6%	50.0%	11.4%	27.3%	28.6%	28.0%	10.3%	22.1%	22.7%	23.1%	21.6%
Private (English Medium)	Count	322	7	64	11	41	0	5	1	45	45	24	1	22	4	2	12	21	166	89	33	915
	% within CD01:	48.9%	31.8%	49.6%	28.9%	44.1%	0.0%	55.6%	100.0%	43.7%	39.1%	47.1%	50.0%	50.0%	36.4%	28.6%	48.0%	72.4%	43.1%	42.2%	30.6%	44.8%
Private (Sindhi Medium)	Count	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
	% within CD01:	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.4%	0.0%	0.0%	0.0%	0.1%
Deeni madrassa	Count	19	0	1	0	1	0	0	0	0	2	0	0	3	0	1	0	0	23	9	16	75
	% within CD01:	2.9%	0.0%	0.8%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	1.7%	0.0%	0.0%	6.8%	0.0%	14.3%	0.0%	0.0%	6.0%	4.3%	14.8%	3.7%
NGO, Foundation, Trust	Count	28	1	5	5	2	0	0	0	3	3	2	0	3	0	0	0	0	11	7	6	76
	% within CD01:	4.2%	4.5%	3.9%	13.2%	2.2%	0.0%	0.0%	0.0%	2.9%	2.6%	3.9%	0.0%	6.8%	0.0%	0.0%	0.0%	0.0%	2.9%	3.3%	5.6%	3.7%
Non Formal Basic Educat	Count	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7
	% within CD01:	0.8%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.3%
Privately schooled	Count	4	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	2	2	5	15
	% within CD01:	0.6%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.9%	4.6%	0.7%

Other	Count	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4
	% within CD01:	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	1.9%	0.2%
Count		659	22	129	38	93	2	9	1	103	115	51	2	44	11	7	25	29	385	211	108	2044
% within CD01: Like the most		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

7.37 CB13: Parent's view of the Child's current performance[a]

		Frequency	%	Valid %	Cumulative %
Valid	Well	1030	21.5	48.5	48.5
	Reasonable/OK	765	16.0	36.0	84.6
	Poorly	292	6.1	13.8	98.3
	Do not know	36	.8	1.7	100.0
	Total	2123	44.4	100.0	
Missing	System	2662	55.6		
Total		4785	100.0		

7.38 CB13: Child current performance * Child gender Crosstabulation[a]

			Child gender 1	Child gender 2	Total
CB13: Child current performance	Well	Count	561	469	1030
		% within Child gender	45.9%	52.1%	48.5%
	Reasonable/OK	Count	449	316	765
		% within Child gender	36.7%	35.1%	36.0%
	Poorly	Count	189	103	292
		% within Child gender	15.5%	11.4%	13.8%
	Do not know	Count	24	12	36
		% within Child gender	2.0%	1.3%	1.7%
Total		Count	1223	900	2123
		% within Child gender	100.0%	100.0%	100.0%

7.39 Parents Know about academic performance[a]

		Frequency	%	Valid %	Cumulative %
Valid	School sends report cards	396	8.3	18.7	18.7
	Parent teacher meetings	476	9.9	22.5	41.2
	Informal communication with school	83	1.7	3.9	45.1
	Other parents/children	61	1.3	2.9	48.0
	I check child's copies	578	12.1	27.3	75.3
	Child tells me	354	7.4	16.7	92.0
	Private tutor	101	2.1	4.8	96.7
	Other	69	1.4	3.3	100.0
	Total	2118	44.3	100.0	
Missing	System	2667	55.7		
Total		4785	100.0		

7.40 Parent Know about academic performance[a]

		Frequency	%	Valid %	Cumulative %
Valid	Parent teacher meetings	168	3.5	23.2	23.2
	Informal communication with school	17	.4	2.4	25.6
	Other parents/children	14	.3	1.9	27.5
	I check child's copies	152	3.2	21.0	48.5
	Child tells me	292	6.1	40.4	88.9
	Private tutor	75	1.6	10.4	99.3
	Other	5	.1	.7	100.0
	Total	723	15.1	100.0	
Missing	System	4062	84.9		
Total		4785	100.0		

7.41 Parent Know about academic performance[a]

		Frequency	%	Valid %	Cumulative %
Valid	Informal communication with school	8	.2	4.6	4.6
	I check child's copies	54	1.1	30.9	35.4
	Child tells me	58	1.2	33.1	68.6
	Private tutor	53	1.1	30.3	98.9
	Other	2	.0	1.1	100.0
	Total	175	3.7	100.0	
Missing	System	4610	96.3		
Total		4785	100.0		

7.42 Parent Know about academic performance[a]

		Frequency	%	Valid %	Cumulative %
Valid	I check child's copies	3	.1	12.0	12.0
	Child tells me	13	.3	52.0	64.0
	Private tutor	9	.2	36.0	100.0
	Total	25	.5	100.0	
Missing	System	4760	99.5		
Total		4785	100.0		

7.43 CD07: Child get Helps MOST[a]

		Frequency	%	Valid %	Cumulative %
Valid	My father	34	.7	1.7	1.7
	My mother	207	4.3	10.1	11.8
	My sibling	265	5.5	13.0	24.8
	Other HH members	59	1.2	2.9	27.6
	Private Tutor	424	8.9	20.7	48.4
	Friend	12	.3	.6	49.0
	No one, I work on my own	999	20.9	48.9	97.8
	Other (specify)_____	44	.9	2.2	100.0
	Total	2044	42.7	100.0	
Missing	System	2741	57.3		
Total		4785	100.0		

7.44 CD08: Child Want to become[a]

		Frequency	%	Valid %	Cumulative %
Valid	I dont know	157	3.3	7.7	7.7
	Full time parent/house wife/house husband	1	.0	.0	7.7
	Religious leader / Hafiz / Imam / Priest	82	1.7	4.0	11.7
	Doctor/Engineer	767	16.0	37.5	49.3
	Teacher	456	9.5	22.3	71.6
	Armed forces	301	6.3	14.7	86.3
	Scientist	5	.1	.2	86.5
	Driver	19	.4	.9	87.5
	Policeman/woman	97	2.0	4.7	92.2
	Nurse	6	.1	.3	92.5
	Lawyer	9	.2	.4	93.0
	Politician/MP/Nazim	3	.1	.1	93.1
	Banker/Accountant	8	.2	.4	93.5
	Singer/Dancer	2	.0	.1	93.6
	TV/Movie star	4	.1	.2	93.8
	Chef	1	.0	.0	93.8
	Mechanic	4	.1	.2	94.0
	Farmer	1	.0	.0	94.1
	Landlord / Zamindar	2	.0	.1	94.2
	Trader/shop keeper	8	.2	.4	94.6
	Civil Servant / Govt. officer	11	.2	.5	95.1
	Sports person	10	.2	.5	95.6
	Journalist/Writer/Poet	1	.0	.0	95.6
	Others (Specify)	89	1.9	4.4	100.0
	Total	2044	42.7	100.0	
Missing	System	2741	57.3		
Total		4785	100.0		

7.45 * Child gender Crosstabulation[a] with CD08: Want to become

CD08: Want to become		Child gender 1 boy	2 girl	Total
I don?t know	Count	87	70	157
	% within Child gender	7.4%	8.1%	7.7%
Full time parent/house wife/house husband	Count	0	1	1
	% within Child gender	0.0%	0.1%	0.0%
Religious leader / Hafiz / Imam / Priest	Count	64	18	82
	% within Child gender	5.4%	2.1%	4.0%
Doctor/Engineer	Count	427	340	767

	% within Child gender	36.2%	39.3%	37.5%
Teacher	Count	91	365	456
	% within Child gender	7.7%	42.2%	22.3%
Armed forces	Count	284	17	301
	% within Child gender	24.1%	2.0%	14.7%
Scientist	Count	5	0	5
	% within Child gender	0.4%	0.0%	0.2%
Driver	Count	19	0	19
	% within Child gender	1.6%	0.0%	0.9%
Policeman/woman	Count	85	12	97
	% within Child gender	7.2%	1.4%	4.7%
Nurse	Count	0	6	6
	% within Child gender	0.0%	0.7%	0.3%
Lawyer	Count	4	5	9
	% within Child gender	0.3%	0.6%	0.4%
Politician/MP/Nazim	Count	3	0	3
	% within Child gender	0.3%	0.0%	0.1%
Banker/Accountant	Count	6	2	8
	% within Child gender	0.5%	0.2%	0.4%
Singer/Dancer	Count	2	0	2
	% within Child gender	0.2%	0.0%	0.1%
TV/Movie star	Count	3	1	4
	% within Child gender	0.3%	0.1%	0.2%
Chef	Count	1	0	1
	% within Child gender	0.1%	0.0%	0.0%
Mechanic	Count	4	0	4
	% within Child gender	0.3%	0.0%	0.2%
Farmer	Count	1	0	1
	% within Child gender	0.1%	0.0%	0.0%
Landlord / Zamindar	Count	1	1	2
	% within Child gender	0.1%	0.1%	0.1%
Trader/shop keeper	Count	8	0	8
	% within Child gender	0.7%	0.0%	0.4%
Civil Servant / Govt. officer	Count	10	1	11
	% within Child gender	0.8%	0.1%	0.5%
Sports person	Count	9	1	10
	% within Child gender	0.8%	0.1%	0.5%
Journalist/Writer/Poet	Count	0	1	1
	% within Child gender	0.0%	0.1%	0.0%
Others (Specify)	Count	65	24	89
	% within Child gender	5.5%	2.8%	4.4%
Total	Count	1179	865	2044
	% within Child gender	100.0%	100.0%	100.0 %

7.46 Child has OPM Assessment file * Child gender Crosstabulation[a]

			Child gender 1	2	Total
Child has Assessment file	No	Count	257	197	454
		% within Child gender	10.0%	8.9%	9.5%
	Yes	Count	2325	2006	4331
		% within Child gender	90.0%	91.1%	90.5%
Total		Count	2582	2203	4785
		% within Child gender	100.0 %	100.0%	100.0%

7.47 CA09: Child's type of school[a]

		Frequency	%	Valid %	Cumulative %
Valid	Government (Urdu Medium)	424	8.9	24.2	24.2
	Government (English Medium)	31	.6	1.8	26.0
	Government (Sindhi)	19	.4	1.1	27.1
	Private (Urdu Medium)	387	8.1	22.1	49.2
	Private (English Medium)	768	16.1	43.9	93.0
	Private (Sindhi Medium)	3	.1	.2	93.2
	Deeni madrassa	57	1.2	3.3	96.5
	NGO, Foundation, Trust	43	.9	2.5	98.9
	Non Formal Basic Education	3	.1	.2	99.1
	Privately schooled	12	.3	.7	99.8
	Other	4	.1	.2	100.0
	Total	1751	36.6	100.0	
Missing	System	3034	63.4		
Total		4785	100.0		

7.48 Descriptives of subject scores and type of school attended

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
Raw score in math test (% correct)	Government (Urdu Medium)	440	.6984	.29607	.01411	.6707	.7261	.00	1.00
	Government (English Medium)	32	.6757	.35004	.06188	.5495	.8019	.00	1.00
	Government (Sindhi)	23	.6545	.32473	.06771	.5141	.7949	.05	1.00
	Private (Urdu Medium)	437	.6667	.29220	.01398	.6392	.6942	.00	1.00
	Private (English Medium)	900	.6950	.30156	.01005	.6753	.7147	.00	1.00
	Private (Sindhi Medium)	2	.7432	.13378	.09459	-.4587	1.9452	.65	.84

	Deeni madrassa	71	.7149	.24732	.02935	.6563	.7734	.05	1.00
	NGO, Foundation, Trust	76	.7543	.25010	.02869	.6971	.8114	.00	1.00
	Non Formal Basic Education	8	.3412	.35207	.12448	.0469	.6356	.00	.86
	Privately schooled	15	.5333	.37303	.09632	.3268	.7399	.00	.95
	Other	4	.8649	.02207	.01103	.8298	.9000	.84	.89
	Total	2008	.6895	.29742	.00664	.6765	.7025	.00	1.00
Raw score in urdu test (% correct)	Government (Urdu Medium)	440	.6275	.28593	.01363	.6007	.6543	.00	1.00
	Government (English Medium)	32	.6250	.31100	.05498	.5129	.7371	.00	1.00
	Government (Sindhi)	23	.5290	.30784	.06419	.3959	.6621	.02	.98
	Private (Urdu Medium)	437	.6405	.29266	.01400	.6130	.6680	.00	1.00
	Private (English Medium)	900	.6568	.29236	.00975	.6377	.6759	.00	1.00
	Private (Sindhi Medium)	2	.8333	.20624	.14583	-1.0197	2.6863	.69	.98
	Deeni madrassa	71	.6690	.24376	.02893	.6113	.7267	.00	1.00
	NGO, Foundation, Trust	76	.7100	.25864	.02967	.6509	.7691	.00	1.00
	Non Formal Basic Education	8	.4297	.36083	.12757	.1280	.7314	.00	.98
	Privately schooled	15	.6028	.31610	.08162	.4277	.7778	.00	1.00
	Other	4	.8542	.21314	.10657	.5150	1.1933	.54	1.00
	Total	2008	.6466	.28968	.00646	.6339	.6592	.00	1.00
Raw score in english test (% correct)	Government (Urdu Medium)	440	.3291	.22135	.01055	.3084	.3498	.00	.98
	Government (English Medium)	32	.3230	.22556	.03987	.2417	.4044	.01	.85
	Government (Sindhi)	23	.3446	.22654	.04724	.2466	.4425	.01	.75
	Private (Urdu Medium)	437	.3424	.21363	.01022	.3223	.3625	.00	.93
	Private (English Medium)	900	.3776	.23445	.00781	.3623	.3929	.00	1.00
	Private (Sindhi Medium)	2	.3063	.13258	.09375	-.8850	1.4975	.21	.40

	Deeni madrassa	71	.3106	.18758	.02226	.2662	.3550	.03	.75
	NGO, Foundation, Trust	76	.4051	.21848	.02506	.3552	.4550	.01	.98
	Non Formal Basic Education	8	.1922	.20144	.07122	.0238	.3606	.01	.57
	Privately schooled	15	.2675	.20931	.05404	.1516	.3834	.01	.82
	Other	4	.4594	.21994	.10997	.1094	.8093	.24	.76
	Total	2008	.3553	.22565	.00504	.3454	.3651	.00	1.00

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Raw score in math test (% correct)	Between Groups	2.153	10	.215	2.451	.007
	Within Groups	175.384	1997	.088		
	Total	177.537	2007			
Raw score in urdu test (% correct)	Between Groups	1.593	10	.159	1.906	.040
	Within Groups	166.825	1997	.084		
	Total	168.417	2007			
Raw score in english test (% correct)	Between Groups	1.566	10	.157	3.107	.001
	Within Groups	100.630	1997	.050		
	Total	102.196	2007			

Null hypothesis is that the mean are the same regardless of the type of school attended. The sig value is less than 1% for maths and English scores and less than 5% for Urdu scores, so we can reject the null hypothesis and assume there is a significant difference between the subject scores and at least one type of school attended. But when we compare govt with private schools there isn't a significant difference. The difference is between govt and NGO foundation school.

7.49 Group Statistics Urdu Govt vs private schools test scores

	CA13: Type of school	N	Mean	Std. Deviation	Std. Error Mean
Raw score in math test (% correct)	Government (Urdu Medium)	440	.6984	.29607	.01411
	Private (Urdu Medium)	437	.6667	.29220	.01398

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Raw score in math test (% correct)	Equal variances assumed	.003	.959	1.596	875	.111	.03170	.01987	-.00729	.07068
	Equal variances not assumed			1.596	874.965	.111	.03170	.01986	-.00729	.07068

Group Statistics urdu govt vs english private

	CA13: Type of school	N	Mean	Std. Deviation	Std. Error Mean
Raw score in math test (% correct)	Government (Urdu Medium)	440	.6984	.29607	.01411
	Private (English Medium)	900	.6950	.30156	.01005

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Raw score in math test (% correct)	Equal variances assumed	.529	.467	.196	1338	.845	.00342	.01744	-.03079	.03763
	Equal variances not assumed			.197	885.943	.844	.00342	.01733	-.03059	.03743

Group Statistics urdu govt vs ngo foundation

	CA13: Type of school	N	Mean	Std. Deviation	Std. Error Mean
Raw score in math test (% correct)	Government (Urdu Medium)	440	.6984	.29607	.01411
	NGO, Foundation, Trust	76	.7543	.25010	.02869

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Raw score in math test (% correct)	Equal variances assumed	4.483	.035	-1.552	514	.121	-.05586	.03600	-.12659	.01486
	Equal variances not assumed			-1.747	114.556	.083	-.05586	.03197	-.11920	.00747

7.50 Subject score Descriptives statistics

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Raw score in math test (% correct)	Male	2325	.5444	.34844	.00723	.5302	.5585	.00	1.00
	Female	2006	.5377	.34525	.00771	.5225	.5528	.00	1.00
	Total	4331	.5413	.34694	.00527	.5309	.5516	.00	1.00
Raw score in urdu test (% correct)	Male	2321	.4764	.32528	.00675	.4632	.4897	.00	1.00
	Female	2004	.4944	.33068	.00739	.4799	.5089	.00	1.00
	Total	4325	.4847	.32788	.00499	.4750	.4945	.00	1.00
Raw score in english test (% correct)	Male	2325	.2516	.21909	.00454	.2427	.2605	.00	1.00
	Female	2006	.2535	.22258	.00497	.2438	.2633	.00	1.00
	Total	4331	.2525	.22069	.00335	.2459	.2591	.00	1.00

ANOVA

	Sum of Squares		df	Mean Square	F	Sig.
Raw score in math test (% correct)	Between Groups	.048	1	.048	.401	.527
	Within Groups	521.142	4329	.120		
	Total	521.190	4330			
Raw score in english test (% correct)	Between Groups	.004	1	.004	.082	.775
	Within Groups	210.883	4329	.049		
	Total	210.887	4330			
Raw score in urdu test (% correct)	Between Groups	.348	1	.348	3.241	.072
	Within Groups	464.501	4323	.107		
	Total	464.849	4324			

Null hypothesis is there is no difference in mean between girls and boys. If Sig is less than 5% = 0.05 we will reject null hypothesis and assume there is a difference between girls and boys. In every case the p-value is more than 5% so can accept null hypothesis that in every subject there is no difference between girls and boys.

7.51 Independent Samples Test for subjects

Levene's Test for Equality of Variances		F	Sig.	t-test for Equality of Means: t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
Raw score in math test (% correct)	Equal variances assumed	.902	.342	.633	4329	.527	.00670	.01057	-.01403	.02742
	Equal variances not assumed			.634	4247.455	.526	.00670	.01057	-.01402	.02741
Raw score in urdu test (% correct)	Equal variances assumed	1.429	.232	-1.800	4323	.072	-.01800	.01000	-.03759	.00160
	Equal variances not assumed			-1.798	4210.584	.072	-.01800	.01001	-.03762	.00162
Raw score in english test (% correct)	Equal variances assumed	.341	.560	-.286	4329	.775	-.00192	.00673	-.01511	.01126
	Equal variances not assumed			-.285	4216.258	.775	-.00192	.00673	-.01512	.01128

All not significant – all red values greater than 0.05 therefore assume no difference in gender means

Paired Samples Test comparing the mean score in maths, urdu and English

		Paired Differences: Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Raw score in math test (% correct) - Raw score in urdu test (% correct)	.05657	.16877	.00257	.05153	.06160	22.042	4324	.000
Pair 2	Raw score in math test (% correct) - Raw score in english test (% correct)	.28874	.21531	.00327	.28232	.29515	88.256	4330	.000
Pair 3	Raw score in urdu test (% correct) - Raw score in english test (% correct)	.23214	.19056	.00290	.22646	.23782	80.117	4324	.000

Each of the subjects are significantly different to the other as the sig test for all is 0.000 at 0.05 and 0.01

7.52 Correlations tests for modelling

		Raw score in math test (% correct)	Raw score in Urdu test (% correct)	Raw score in English test (% correct)
Raw score in math test (% correct)	Pearson Correlation	1	.876**	.801**
	Sig. (2-tailed)		.000	.000
	N	4331	4325	4331
Raw score in urdu test (% correct)	Pearson Correlation	.876**	1	.828**
	Sig. (2-tailed)	.000		.000
	N	4325	4325	4325
Raw score in english test (% correct)	Pearson Correlation	.801**	.828**	1
	Sig. (2-tailed)	.000	.000	
	N	4331	4325	4331

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation shows a 99% significant between the scores in the three subjects

Bivariate regression analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.876[a]	.768	.768	.15792

a. Predictors: (Constant), Raw score in math test (% correct)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	357.041	1	357.041	14316.911	.000[b]
	Residual	107.809	4323	.025		
	Total	464.849	4324			

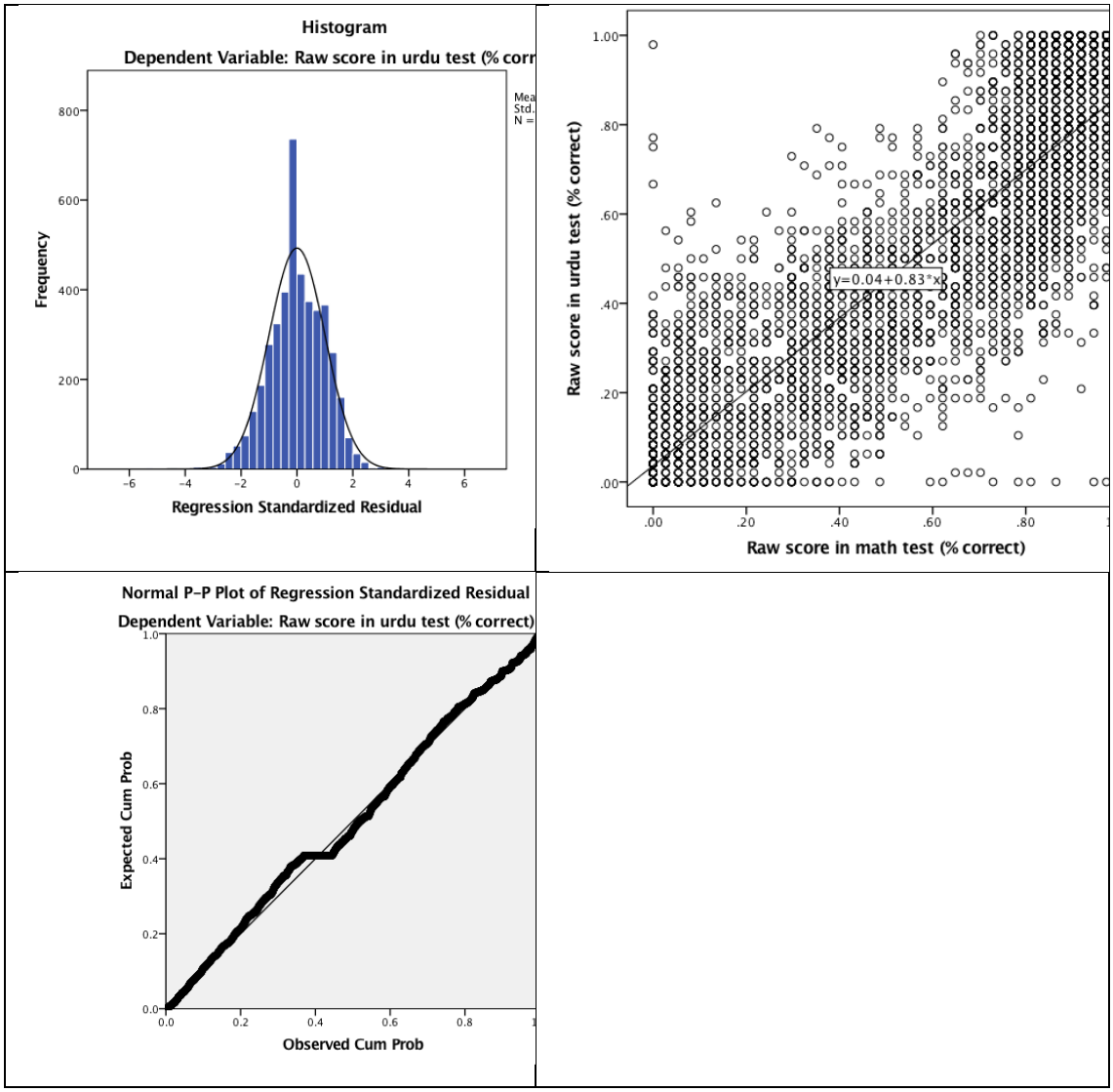
a. Dependent Variable: Raw score in Urdu test (% correct)

b. Predictors: (Constant), Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.036	.004		8.181	.000
	Raw score in math test (% correct)	.828	.007	.876	119.653	.000

a. Dependent Variable: Raw score in urdu test (% correct)



Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.801[a]	.642	.642	.13203

a. Predictors: (Constant), Raw score in math test (% correct)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	135.428	1	135.428	7769.409	.000[b]
	Residual	75.459	4329	.017		
	Total	210.887	4330			

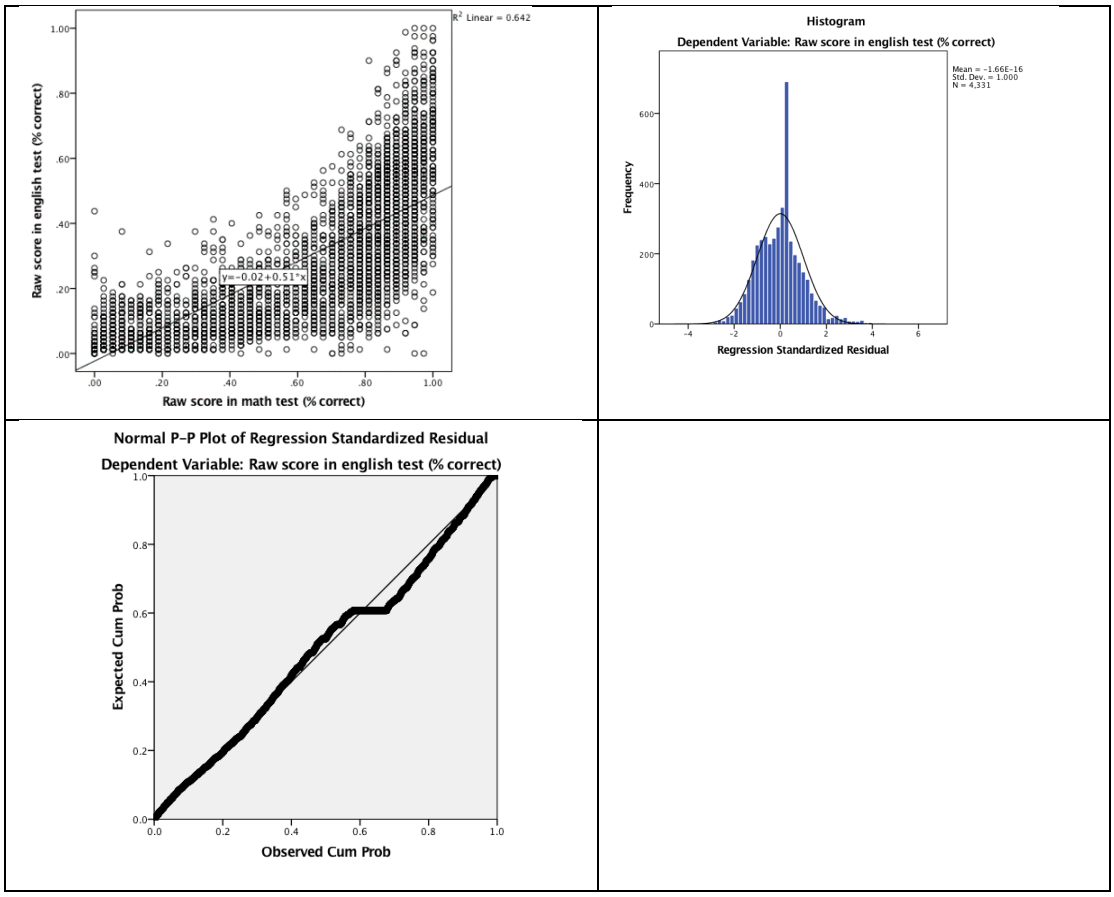
a. Dependent Variable: Raw score in english test (% correct)

b. Predictors: (Constant), Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-.023	.004		-6.291	.000
	Raw score in math test (% correct)	.510	.006	.801	88.144	.000

a. Dependent Variable: Raw score in english test (% correct)



7.53 CA06: Chd ever been Enrolled * HB03: Family members ever attended school Crosstabulation

tpHB03: Family members ever attended school			Yes, Currently attending	Previously attended	Never attended	Total
CA06: Chd ever been Enrolled	Yes	Count	344	157	13	514
		% within HB03: Family members ever attended school	97.7%	83.5%	8.0%	73.1%
	No	Count	8	31	150	189
		% within HB03: Family members ever attended school	2.3%	16.5%	92.0%	26.9%
Total	Count		352	188	163	703
	% within HB03: Family members ever attended school		100.0%	100.0%	100.0%	100.0%

Descriptives – relationship between maths scores and family members attending school

7.54 ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Raw score in math test (% correct)	Between Groups	8.036	2	4.018	91.303	.000
	Within Groups	28.032	637	.044		
	Total	36.068	639			
Raw score in urdu test (% correct)	Between Groups	13.318	2	6.659	125.110	.000
	Within Groups	33.850	636	.053		
	Total	47.168	638			
Raw score in english test (% correct)	Between Groups	8.845	2	4.423	117.737	.000
	Within Groups	23.928	637	.038		
	Total	32.773	639			

99% significant shows that at least one test score is different in each subject based on the family members' history in education

Raw score in math test (% correct)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Yes, Currently attending	333	.8733	.15265	.00837	.8568	.8898	.00	1.00
Previously attended	165	.7995	.20971	.01633	.7673	.8317	.00	1.00
Never attended	142	.5895	.30460	.02556	.5389	.6400	.00	1.00
Total	640	.7913	.23758	.00939	.7729	.8097	.00	1.00

ANOVA

Raw score in math test (% correct)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.036	2	4.018	91.303	.000
Within Groups	28.032	637	.044		
Total	36.068	639			

7.55 T test for maths scores and family members attending school

Group Statistics

HB03: Family members ever attended school		N	Mean	Std. Deviation	Std. Error Mean
Raw score in math test (% correct)	Yes, Currently attending	333	.8733	.15265	.00837
	Previously attended	165	.7995	.20971	.01633

Group Statistics

HB03: Family members ever attended school		N	Mean	Std. Deviation	Std. Error Mean
Raw score in math test (% correct)	Never attended	142	.5895	.30460	.02556
	Previously attended	165	.7995	.20971	.01633

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Diff	
	.	F	Sig	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Raw score in math test (% correct)	Equal variances assumed	35.558	.000	-7.114	305	.000	-.21005	.02953	-.26816	-.15195
	Equal variances not assumed			-6.925	244.517	.000	-.21005	.03033	-.26980	-.15031

Group Statistics

	HB03: Family members ever attended school	N	Mean	Std. Deviation	Std. Error Mean
Raw score in math test (% correct)	Never attended	142	.5895	.30460	.02556
	Previously attended	165	.7995	.20971	.01633

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Raw score in math test (% correct)	Equal variances assumed	134.850	.000	-13.499	473	.000	-.28385	.02103	-.32517	-.24253
	Equal variances not assumed			-10.554	171.982	.000	-.28385	.02690	-.33694	-.23076

99% significant that family members' involvement in education has an impact on maths scores

7.56 CA05: Child's Language at home

		Frequency	%	Valid %	Cumulative %
Valid	Mainly Urdu	1438	9.3	30.1	30.1
	Mainly English	2	.0	.0	30.1
	Mainly Sindhi	267	1.7	5.6	35.7
	Mainly Pushto	1807	11.7	37.8	73.5
	Mainly Balochi	276	1.8	5.8	79.2
	Mixture of languages	171	1.1	3.6	82.8
	Gilgiti/Baltistani/Kashmiri	7	.0	.1	82.9
	Siraiki	168	1.1	3.5	86.5
	Punjabi	321	2.1	6.7	93.2
	Brohi	15	.1	.3	93.5
	Others	312	2.0	6.5	100.0
	Total	4784	31.1	100.0	
Missing	System	10620	68.9		
Total		15404	100.0		

7.57 CD05: Child's language at School Language

		Frequency	%	Valid %	Cumulative %
Valid	Mainly Urdu	1685	10.9	82.4	82.4
	Mainly English	103	.7	5.0	87.5
	Mainly Sindhi	18	.1	.9	88.4
	Mainly Pushto	116	.8	5.7	94.0
	Mixture of languages	116	.8	5.7	99.7
	Others	6	.0	.3	100.0
	Total	2044	13.3	100.0	
Missing	System	13360	86.7		
Total		15404	100.0		

7.58 Descriptives maths scores and the language spoken at home

Raw score in math test (% correct)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Mainly Urdu	1360	.5895	.33971	.00921	.5714	.6076	.00	1.00
Mainly English	2	.8108	.11467	.08108	-.2194	1.8410	.73	.89
Mainly Sindhi	235	.5256	.35743	.02332	.4797	.5715	.00	1.00
Mainly Pushto	1603	.5056	.34776	.00869	.4886	.5226	.00	1.00
Mainly Balochi	236	.5437	.36088	.02349	.4975	.5900	.00	1.00
Mixture of languages	153	.5435	.33108	.02677	.4907	.5964	.00	1.00
Gilgiti/Baltistani/Kashmiri	7	.7683	.17850	.06747	.6033	.9334	.49	.92
Siraiki	157	.5151	.34014	.02715	.4614	.5687	.00	1.00
Punjabi	288	.5325	.34044	.02006	.4930	.5720	.00	1.00
Brohi	9	.4174	.44720	.14907	.0737	.7612	.00	1.00
Others	281	.5409	.34998	.02088	.4998	.5820	.00	1.00
Total	4331	.5413	.34694	.00527	.5309	.5516	.00	1.00

ANOVA

Raw score in math test (% correct)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.040	10	.604	5.065	.000
Within Groups	515.150	4320	.119		
Total	521.190	4330			

Null hypothesis is that the mean score in maths is the same in every language. But the p-value is less than 0.01 so we can reject the null hypothesis and assume there is a difference in maths scores based on the language spoken at home

7.59 Group Statistics for children who speak Urdu or pushto at home

CA05: Child Language at home		N	Mean	Std. Deviation	Std. Error Mean
Raw score in math test (% correct)	Mainly Urdu	1360	.5895	.33971	.00921
	Mainly Pushto	1603	.5056	.34776	.00869
Raw score in urdu test (% correct)	Mainly Urdu	1360	.5195	.32514	.00882
	Mainly Pushto	1603	.4781	.32327	.00807
Raw score in english test (% correct)	Mainly Urdu	1360	.2852	.22655	.00614
	Mainly Pushto	1603	.2237	.20447	.00511

Independent Samples Test

Levene's Test for Equality of Variances		F	Sig.	t-test for Equality of Means: t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
Raw score in math test (% correct)	Equal variances assumed	4.311	.038	6.615	2961	.000	.08392	.01269	.05905	.10879
	Equal variances not assumed			6.628	2903.061	.000	.08392	.01266	.05909	.10874
Raw score in urdu test (% correct)	Equal variances assumed	.237	.626	3.464	2961	.001	.04140	.01195	.01797	.06483
	Equal variances not assumed			3.463	2877.475	.001	.04140	.01196	.01796	.06484
Raw score in english test (% correct)	Equal variances assumed	34.567	.000	7.761	2961	.000	.06148	.00792	.04595	.07701
	Equal variances not assumed			7.696	2765.841	.000	.06148	.00799	.04582	.07715

There is a statistically significant difference between the scores in all three subjects between children who speak Urdu or pushto at home, the most common languages.

7.60 Descriptives subject score and language of school

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean: Lower Bound	Upper Bound	Minimum	Maximum
Raw score in math test (% correct)	Mainly Urdu	1628	.6914	.29510	.00731	.6771	.7057	.00	1.00
	Mainly English	95	.7104	.31653	.03248	.6459	.7749	.00	1.00
	Mainly Sindhi	16	.7095	.30201	.07550	.5485	.8704	.05	1.00
	Mainly Pushto	108	.6552	.28890	.02780	.6000	.7103	.00	1.00
	Mixture of languages	110	.7128	.28979	.02763	.6580	.7675	.00	1.00
	Others	6	.6937	.37554	.15331	.2996	1.0878	.00	1.00
	Total	1963	.6917	.29565	.00667	.6786	.7048	.00	1.00
Raw score in urdu test (% correct)	Mainly Urdu	1628	.6463	.28704	.00711	.6324	.6603	.00	1.00
	Mainly English	95	.6570	.31840	.03267	.5922	.7219	.00	1.00
	Mainly Sindhi	16	.4974	.36892	.09223	.3008	.6940	.00	1.00
	Mainly Pushto	108	.6341	.27028	.02601	.5825	.6856	.00	1.00
	Mixture of languages	110	.7002	.26315	.02509	.6505	.7499	.00	1.00

	Others	6	.6076	.31552	.12881	.2765	.9388	.06	.90
	Total	1963	.6478	.28751	.00649	.6351	.6606	.00	1.00
Raw score in english test (% correct)	Mainly Urdu	1628	.3577	.22530	.00558	.3468	.3687	.00	.99
	Mainly English	95	.4183	.26311	.02699	.3647	.4719	.01	1.00
	Mainly Sindhi	16	.3484	.23878	.05970	.2212	.4757	.01	.75
	Mainly Pushto	108	.2579	.16333	.01572	.2267	.2890	.00	.75
	Mixture of languages	110	.3801	.20638	.01968	.3411	.4191	.00	.85
	Others	6	.2250	.11124	.04541	.1083	.3417	.04	.30
	Total	1963	.3559	.22473	.00507	.3460	.3659	.00	1.00

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Raw score in math test (% correct)	Between Groups	.231	5	.046	.529	.754
	Within Groups	171.260	1957	.088		
	Total	171.492	1962			
Raw score in urdu test (% correct)	Between Groups	.706	5	.141	1.710	.129
	Within Groups	161.481	1957	.083		
	Total	162.186	1962			
Raw score in english test (% correct)	Between Groups	1.581	5	.316	6.347	.000
	Within Groups	97.511	1957	.050		
	Total	99.092	1962			

Null hypothesis is that the mean score in maths is the same in every school language. But the p-value is more than 0.01 so we accept the null hypothesis and assume there is no difference in maths and Urdu scores based on the language of school. But the language of instruction has a statistically significant difference on the scores in English.

7.61 Multivariate regression analysis – developing a model for mathematics tests scores

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.010[a]	.000	.000	.34696

a. Predictors: (Constant), Child gender
b. Dependent Variable: Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	.551	.016		33.716	.000	.519	.583
	Child gender	-.007	.011	-.010	-.633	.527	-.027	.014

a. Dependent Variable: Raw score in math test (% correct)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.585[a]	.342	.342	.28152

a. Predictors: (Constant), CA04: Child Age
b. Dependent Variable: Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	-.057	.013		-4.262	.000	-.083	-.031
	CA04: Child Age	.077	.002	.585	47.406	.000	.074	.081

a. Dependent Variable: Raw score in math test (% correct)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.008[a]	.000	.000	.34697

a. Predictors: (Constant), CA05: Child Language at home

b. Dependent Variable: Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	.543	.006		93.545	.000	.531	.554
	CA05: Child Language at home	.000	.000	-.008	-.554	.579	-.001	.000

a. Dependent Variable: Raw score in math test (% correct)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.003[a]	.000	-.001	.29572

a. Predictors: (Constant), CD05: School Language
b. Dependent Variable: Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	.691	.010		68.360	.000	.671	.711
	CD05: School Language	.001	.005	.003	.124	.901	-.009	.010

a. Dependent Variable: Raw score in math test (% correct)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.503[a]	.253	.253	.29989

a. Predictors: (Constant), CA06: Chd ever been Enrolled
b. Dependent Variable: Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	1.042	.014		75.204	.000	1.015	1.070
	CA06: Chd ever been Enrolled	-.354	.009	-.503	-38.283	.000	-.372	-.336

a. Dependent Variable: Raw score in math test (% correct)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.015[a]	.000	.000	.24470

a. Predictors: (Constant), CA09: Type of school chd attends

b. Dependent Variable: Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	.764	.009		89.879	.000	.747	.781
	CA09: Type of school chd attends	-.001	.001	-.015	-.616	.538	-.004	.002

a. Dependent Variable: Raw score in math test (% correct)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.456[a]	.208	.207	.21163

a. Predictors: (Constant), HB03: Family members ever attended school

b. Dependent Variable: Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	1.019	.019		52.268	.000	.981	1.057
	HB03: Family members ever attended school	-.134	.010	-.456	-12.936	.000	-.154	-.114

a. Dependent Variable: Raw score in math test (% correct)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.013[a]	.000	-.002	.17705

a. Predictors: (Constant), HB05: Highest class passed

b. Dependent Variable: Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	.848	.009		98.235	.000	.831	.865
	HB05: Highest class passed	.000	.001	.013	.284	.777	-.002	.002

a. Dependent Variable: Raw score in math test (% correct)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.464[a]	.215	.214	.21064

a. Predictors: (Constant), HB01: Parent Can Read
b. Dependent Variable: Raw score in math test (% correct)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	1.103	.025		44.093	.000	1.054	1.153
	HB01: Parent Can Read	-.229	.017	-.464	-13.225	.000	-.263	-.195

a. Dependent Variable: Raw score in math test (% correct)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.134[a]	.018	-.016	.25234

a. Predictors: (Constant), HC01: Parent Work for pay
b. Dependent Variable: Raw score in math test (% correct)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.802[a]	.644	.593	.19963

a. Predictors: (Constant), HC04: Parent Main occupation

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.

1	(Constant)	.174	.172		1.007	.347
	HC04: Parent Main occupation	.082	.023	.802	3.557	.009

a. Dependent Variable: Raw score in math test (% correct)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.193[a]	.037	.037	.29191

a. Predictors: (Constant), CB13: Child current performance

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.783	.012		62.824	.000
	CB13: Child current performance	-.053	.006	-.193	-8.804	.000

a. Dependent Variable: Raw score in math test (% correct)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.105[a]	.011	.002	.34616

a. Predictors: (Constant), CC01B: Think what child will become

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.564	.036		15.746	.000
	CC01B: Think what child will become	-.002	.002	-.105	-1.113	.268

a. Dependent Variable: Raw score in math test (% correct)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.092[a]	.009	.008	.34550

a. Predictors: (Constant), CC04A: Printed media

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.700	.026		26.444	.000

	CC04A: Printed media	-.086	.014	-.092	-6.105	.000

a. Dependent Variable: Raw score in math test (% correct)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.050[a]	.002	.002	.33092

a. Predictors: (Constant), CE01: Worked

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.719	.044		16.460	.000
	CE01: Worked	-.070	.022	-.050	-3.120	.002

a. Dependent Variable: Raw score in math test (% correct)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.693[a]	.481	.480	.25009

a. Predictors: (Constant), CA06: Chd ever been Enrolled, CA05: Child Language at home, CA04: Child Age

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.424	.018		23.015	.000
	CA04: Child Age	.065	.001	.492	43.548	.000
	CA05: Child Language at home	-.001	.000	-.029	-2.658	.008
	CA06: Chd ever been Enrolled	-.270	.008	-.383	-33.921	.000

a. Dependent Variable: Raw score in math test (% correct)