ACTA UNIVERSITATIS GOTHOBURGENSIS
GOTHENBURG STUDIES IN EDUCATIONAL SCIENCES 462

Exploring socioeconomic inequality in educational opportunity and outcomes in Sweden and beyond

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Abstract

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This doctoral thesis aims to explore Sweden's achievement gap in international assessment and how this may have developed in the context of a network of educational inequalities. Theoretically grounded in the Model of Potential Educational Experiences (Schmidt, Raizen, Britton, Bianchi, & Wolfe, 1997), the thesis investigates how the relationship between the intended and attained curriculum is moderated by actions at the classroom level. Teacher implementation of the curriculum provides opportunities for students to learn yet is a source of inequity in the school system.

Student socioeconomic background and the amount of subject content (or Opportunity to Learn – OTL) they are exposed to are judged to significantly influence student outcomes. Socioeconomic inequality of outcomes has been perennially observed in educational assessment and has been a topic of investigation since the mid-twentieth century, while a body of literature suggests that there is an equality gap in OTL, with more advantaged students offered more content coverage through their mathematics lessons.

This compilation thesis features an integrative essay and three empirical studies, which apply statistical analysis to data from two international large-scale assessments, PISA and TIMSS. Study I investigated the measurement of socioeconomic status over time in Sweden. After establishing which questionnaire items consistently appeared in PISA, a measurement model bespoke to Sweden was constructed from 2000 data. The model was found to be replicable and trustworthy over time, establishing an alternative measure of SES applicable to 15 years of Swedish PISA data. In Study II socioeconomic inequalities in opportunity and outcomes in mathematics and science, and the

question as to whether unequal opportunities perpetuate unequal outcomes were investigated in 78 countries using 4 cycles of TIMSS data. Achievement gaps were observed near universally. These achievement gaps were strong and increased across the cycles of TIMSS. Opportunity gaps were less frequently observed, and evidence that schooling exacerbates socioeconomic inequalities in outcomes was confined to a select group of countries including England, Malta, Scotland, and Singapore. Sweden's achievement gap was consistent across the time points, and an opportunity gap was only observed in half the cycles. Finally, schooling mediated the effects of SES on achievement in only the 2003 cycle for Sweden, suggesting equitable mathematics provision in Sweden.

Teachers are essential to the implementation of the curriculum, and their actions affect the experiences of students. Multiple inequalities in Swedish classrooms were explored in Study III. The 2015 TIMSS cycle was grouped by whether or not teachers were mathematics specialists. Overall, Swedish mathematics students experienced substantial gaps in achievement, opportunity and teacher quality. However, differing patterns of inequalities emerged in the grouped model. Among classes with specialist teachers there was a moderate opportunity gap, while those with non-specialists had a teacher quality gap. In both groups there was a socioeconomic gap in teacher perception of school ethos towards academics. The findings of this study underscore the importance of having high-quality teachers in mathematics classrooms as a temper of outcome inequity.

Collectively, the findings of the constituent studies confirm the persistence of the achievement gap in Sweden and globally, contextualize the opportunity gap in Sweden, and underline the importance of item choice and construct measurement when modelling inequality using international data. Suggestions are made for further research integrating the thesis's contribution to construction measurement into trend analyses of opportunity gaps, and combining register and international data to parse how changes in teacher education may affect equality in Swedish classrooms.

Contents

List of tables and figures

To Sarah and Ralph

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The FUR group has become my research home over the past five years. Over the course of many Wednesday meetings, seminars, and conference trips, you have been a space for me to grow as a scientist, both challenging and championing my work, and I thank you all. Through the FUR group, I have also developed wonderful friendships with many of the past and current doctoral student cadre who have enriched this experience exponentially.

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The defence of this thesis marks the end of a cumulative twenty-seven years of studying. This achievement is testament to the determination and drive fostered by my wonderful family. M&D, G&C&CB, G&G, and L: your unwavering faith and support over the last five years have been invaluable.

The last twelve months of the doctoral process, the 'writing up' phase, has been incredibly tough. A global pandemic, it transpires, adds an unforeseen and decidedly unwelcome level of additional difficulty to the endeavour. I would like to extend my profound gratitude to my friends, both in Gothenburg and London, for their company – be it socially distanced or over Zoom – love and humour. Your support has propelled me though this final furlong. Especial

thanks are reserved for my dearest friends: A&M you have given me so much encouragement and the treasured offer of a sofa to crash on in London when this process felt overwhelming. I can never repay you.

Finally, an apology. In July 2010 I was in the French Alps, bawling my eyes out because I had just learned I had got a 'Richard' in my BA. G&G and J&J, you sat me down, handed me a G&T and told me it would all be all right. You cited various people from your graduating class at UCL in the early 1960s who had the same degree grade as I now had and yet still went on to careers in academia or the City. I was inconsolable; convinced that in this day and age I would never even get a job making the tea for the person who fetched the coffee. Well, you were right. It has been a long and sometimes difficult road, but it all turned out OK and I did end up doing something interesting, cool and clever. Thank you.

Gothenburg, April 2021

Preface

The first question that anyone asks when I say that I am studying for a PhD is "What is your research about?" Over the past five years, I have developed a quick and easy answer for use in social situations: "It is about pupils' backgrounds, their opportunities in school, and their outcomes. And it is mostly set in Sweden". When I am pressed as to explain why this matters, and why it is worth investigating, I think back to my own school days.

When I was 16, I sat my GCSEs. In my school, pupils – nearly 250 of them, had been ranked two years earlier at the end of year 9 and then divided into sets 1 to 10 for mathematics. These sets, which were strictly grouped by ability, had then been taught different tiers of the mathematics syllabus. At the end of year 11 when we sat our examinations, pupils in the Higher tier were eligible for grades A*-C. Those in the Intermediate tier grades B-E, and those in the Foundation tier grades D-G. Continuing with mathematics to A-level (essential for applying to many university courses) required an A or A* in this exam. Grade C in GCSE Mathematics and English were the basic qualifications required for almost all employment or further training, yet some of my classmates were not taking courses with that as a possible outcome. Opportunities to succeed were so radically different, and my 16-year-old-self sitting in Set 1 did not realise that I was already on an express track to greater opportunities – an A* at GCSE, A-level maths class, a prestigious university – while some of my peers were barely in the station.

I have had the great privilege to study a topic that I am passionate about. While the doctoral research process can be famously all-consuming, working within the CHOICE project came with in-built distance from my research. Using large-scale international data I could be sat next to an individual in one of my studies on the bus and never know it. Focusing on Sweden in my integrating essay removes me from my early noughties experiences as a pupil. Despite living in Sweden for nearly eight years now, when it comes to the Swedish school system, I am an outsider. I served my time in English schools, both as a student and as a trainee teacher. Aside from returning the occasional stray football over the fence, the sum of my interaction with Swedish schools

has been as an evening student of Swedish through Gothenburg's municipal adult education program. I have never studied, taught, or parented here. Nevertheless, in undertaking this doctoral project I have learnt an awful lot about Sweden and the Swedish education system, and I hope my contribution is of use to the insiders.

Chapter 1 Introduction

For the majority of the twentieth century, the provision of equal educational opportunities in an integrated setting, regardless of a student's background, was a hallmark of the Swedish educational system (Arnesen & Lundahl, 2006). The comprehensive 'School for All' approach to education was shared with Sweden's Nordic neighbours and formed a keystone of the socio-democratic welfare state. However, by the 2000s a socioeconomic achievement gap started to become evident in Sweden, with increasing numbers of students failing to receive a full suite of passing grades at the end of compulsory schooling, and a growing variation in performance between schools (The National Agency for Education, 2005). The achievement gap remains evident in Sweden today (The National Agency for Education, 2020a), with the effect of student social background on final grades in compulsory school having increased since the early 2000s (Löfstedt, 2019). The existence of a socioeconomic achievement gap in the domestic setting is mirrored by growing achievement gap in Swedish performance in international assessments (e.g. Mullis, Martin, Foy, & Hooper, 2016; 2017; OECD, 2016).

The two phenomena that this thesis aims to explore, inequalities in outcomes and inequalities in opportunities, are best understood as a structural absence of equality in these two areas. While the promotion of equality through education has long been recognised as perhaps the pre-eminent theme in education throughout the world (Coleman, 1990), the characteristic through which equality is evaluated has shifted over time. The mid-twentieth century focus on educational differences between ethnic groups, such as the landmark Coleman Report (1966), has given way to a centring around socioeconomic status (e.g. Baker, Goesling, & LeTendre, 2002; Broer, Bai, & Fonseca, 2019; Keeves, 1992), to the extent that socioeconomic inequality in outcomes is one of the principal pedagogic and political concerns of our age (Jerrim, Volante, Klinger, & Schnepf, 2019).

Two conceptually distinct but empirically linked aspects of the inequality construct are inequality in dispersion of outcomes and inequality of opportunity as an influence of background characteristics on outcomes (Van de Werfhorst

& Mijs, 2010). An educational system might demonstrate inequality in the first instance by exhibiting large achievement gaps between top and bottom performing students and secondly by offering differing pathways limiting achievement opportunities to differing groups of students (see, Boudon, 1974; Erikson, Goldthorpe, Jackson, Yaish, & Cox, 2005; Goldthorpe, 1996; Van de Werfhorst & Mijs, 2010).

A mechanism for reaching equality of outcomes, educational equity seeks to close the inequality gaps which privilege more advantaged socioeconomic groups. To provide equitable opportunities and outcomes, it is necessary that these be unequally distributed among socioeconomic groups. In equitable scenarios the inequality should benefit marginalised groups, in this case the socioeconomically disadvantaged. Globally the implementation of equitable education is a necessary goal for two reasons. Firstly access to quality education and opportunity is a basic right at an individual level (United Nations, 1989). Secondly educational equity is economically imperative insofar as society benefits when the citizenry are well educated and education is a mechanism for marginalised groups to empower themselves (Cavicchioni & Motivans, 2002). Schooling is a hierarchical endeavour with students nested in classrooms, in schools, in countries. At each level of the school system there are organizational choices which impact equity, including school financing (Berne & Stiefel, 1984), system selectiveness, school structure and between-school segregation (Duru-Bellat & Suchaut, 2005), teacher distribution (Mason-Williams, 2015) and student choice (Musset, 2012). At a fundamental level, "equity in educational attainment is […] seen as a core driver for enhanced economic equity, both of which are equated in much policy rhetoric with notions of social inclusion, mobility and justice" (Raffo, 2011, p. 326). Unequal and inequitable educational opportunities are a hallmark of academically differentiated education systems. While Sweden is renowned for its free and comprehensive School for All, differentiated provision has been a feature of the Swedish education system at multiple points in its history.

Sweden has a long history of education for the public good. Swedes have been required to reach a basic standard of literacy since the Lutheran Reformation (Lundgren, 2015), with more extensive education the preserve of the privileged few. Universal formal education for children was introduced in 1842 which was overseen initially by the Church. In the early part of the twentieth century a series of reforms introduced the first national curriculum, increased oversight from national actors, and eventually transfered control to

municipalities in 1930 (SOU 2014:5). In this early period, educational progression in Sweden was heavily predicated by social background (Boalt, 1947), with a tradition of educational stratification which divided children by social class into parallel academic and vocational school systems (e.g. Husén & Härnqvist, 2000). This tracked system resulted in documented opportunity and achievement gaps between Swedish youth of differing socioeconomic backgrounds, with working class children bared from university by academic segregation early in their school careers (see Husén & Härnqvist, 2000). During the post-war period, Sweden's education system underwent a series of reforms, introducing a 9-year long comprehensive compulsory school in 1962, and integrating the delivery of both academic and vocational post-secondary programmes into one upper-secondary school in 1970 (Lundahl, 2002), working on a compensatory principle (e.g. Haug, 1999) to reduce the socioeconomic gaps in opportunities and outcomes. The provision of equitable education, which provided pupils the opportunity to progress in life, was enshrined in law and curriculum in the 1980s (e.g. SFS 1985:1100). Similar reforms occurred concurrently in neighbouring countries, with a key feature of this Nordic model of education being the prominent placement of equitable education as a driver of social development (e.g. Lundahl, 2016). While the Swedish compulsory school remains comprehensive, reforms were implemented in the 1990s under the auspices of new public management (e.g. Björklund, Clark, Edin, Fredriksson, & Krueger, 2005; Lundahl, 2002), with the aim of raising academic performance through competition (Lundahl, Arreman, Holm, & Lundström, 2013). As a consequence of these reforms – decentralization and marketization through the introduction of school choice and independent schools – differentiated provision was reintroduced and equality in schooling decreased (Lundahl et al., 2013). Rather than the prior explicit vocational vs. academic divide, Swedish schools came to be characterised by social and cultural segregation and increased variation in student outcomes (e.g. Östh, Andersson, & Malmberg, 2013; The National Agency for Education, 2010; SOU 2014:5), invigorating academic discourse around socioeconomic gaps in Swedish education system today which this thesis aims to contribute empirical evidence to.

Research aims

Persistent and increasing socioeconomic achievement gaps, both in Sweden and abroad (Broer et al., 2019; Chmielewski, 2019), suggest that in addition to educational systems failing to promote equal outcomes, they might also be vehicles of inequity by not counteracting socioeconomic dominance of outcomes through the compensatory offering of opportunities. This thesis aims to explore the socioeconomic achievement and opportunity gaps that have emerged in international assessment, particularly the ways in which these may have developed in the context of changes in educational equity. Sweden is the primary site of enquiry, with comparative multi-national studies deployed in order to examine various theoretical assumptions made of the constructs utilised in the thesis.

This thesis consists of an integrative essay and three empirical studies, which investigate socioeconomic inequalities in education from different perspectives. The trio of empirical papers presented within this thesis seek to answer the following research questions: (i) *How might socioeconomic status be consistently measured over time?* (ii) *How do unequal opportunities relate to unequal outcomes?* (iii) *How can inequality be contextualised in Swedish schools?* Although these research questions are addressed within the empirical studies successively, the contributions of the papers are considered complementarily in the Integrated Discussion of the thesis in Chapter 6.

Study I investigates the measurement of socioeconomic status over time in Sweden. Considering the changes to Swedish demographics, in conjunction with the broader social and technological advances of the twenty-first century, the study builds a measurement model of socioeconomic status which is applicable over a 15 year period. The alignment optimization method is applied to verify the model.

A cross-country view is taken in **Study II** to explore the interplay of socioeconomic status, opportunity to learn and achievement. In addition to the well documented relationship between socioeconomic origin and student achievement the study considers how student origin relates to the learning opportunities offered within the classroom setting. These two threads of inquiry are subsequently intertwined by assessing how opportunity to learn mediates the relationship between socioeconomic status and achievement in mathematics and science.

Study III hones in on inequalities between Swedish classrooms. Given the patterns of inequalities previously explored in Study II, consideration is given to teacher quality and learning climate in eighth-grade mathematics classrooms. Sweden's highly marketised and choice-driven school system is integrated into the study, comparing inequalities between classes with specialist and non-specialist teachers. Key implications of this study are how teacher behaviour might be a driver of disparities in mathematics provision between more and less socioeconomically advantaged classes of students.

These three studies, when taken as a whole, reiterate the presence and persistence of the achievement gap in Swedish mathematics performance. The relationship between socioeconomic origins and opportunities offered within mathematics classrooms is examined as an explanatory factor of this achievement gap both internationally and within Sweden. The web of inequalities found in Swedish schools are used to contextualise the discrepancies between the mathematics curriculum as examined in international assessments and the curriculum as administered in Swedish schools, which forms the principal thread of the integrated discussion in this thesis.

The proceeding content of the dissertation is organized as follows: In Chapter 2 the reader is furnished with an overview of the educational landscape in Sweden. A review of the literature concerning the theoretical constructs explored in this thesis is presented in Chapter 3. Chapter 4 situates the dissertation within the theoretical framework of the TIMSS Model of Potential Educational Experiences. The methodology used in the thesis is discussed in Chapter 5, while Chapter 6 presents the findings of the empirical studies alongside an integrated discussion, before assessing the contribution of the dissertation to the field, and making recommendations for further research. A summary in Swedish of the integrative essay follows. Finally, the empirical studies are presented.

Chapter 2 Background

A pioneer in the introduction of compulsory schooling (Björklund et al., 2005; Husén, 1989), Sweden has long enjoyed a reputation for being a socio-democratic welfare-state (e.g. Esping-Andersen, 1996). Education is a key component of this social model. In this chapter key educational reforms and social changes of the last 30 years are introduced and considered, establishing the context in which this thesis's exploration of inequalities in outcomes and opportunities in Sweden are situated.

Educational reform in Sweden

Since the early-1990s, the Swedish school system has fundamentally changed, becoming increasingly marketized, with the delegation of education from central to local governmental control, the widespread proliferation of privately run state-financed independent schools (free schools), and the promotion of parental choice. Since the implementation of the parental right to choose one's child's school in July 1992, the proportion of independent schools in Sweden has increased from around 5% in 1997 to 17% in 2020, with these independent schools currently enrolling 15% of compulsory school aged children (The National Agency for Education, 2018b, 2020b). Contemporary Swedish students, especially those in metropolitan areas, have a wide array of schools to choose from. This variety of schools may offer a multitude of differing opportunities, particularly at the post compulsory level (Lundahl, 2016).

Concurrent to this period of reform the Swedish welfare system deteriorated: both income difference (Aaberge et al., 2018) and residential segregation increased (Bevelander, 2004; Malmberg, Nielsen, Andersson, & Haandrikman, 2016). With a tradition of welcoming immigrants, Sweden has accepted over 600,000 refugees for resettlement between 1980 and 2017 (The Swedish Migration Agency, 2018). The inflow of immigrants has increased the amount of students with a migration background, and there has been a documented growth of students eligible for language support (either mother tongue instruction or Swedish as an additional language) from 12% in 2000 to in 25% (The National Agency for Education, 2018c, 2018d), and a persistent

achievement gap between students with and without a foreign background (e.g. Bryman & Cramer, 2011; OECD, 2006; The National Agency for Education, 2005). There are reasons to assume that the recent school reforms, coupled with the societal changes enacted within the Swedish school system are considered a possible precursor of a period of fluctuation in achievement and a noted achievement gap.

Evolving funding and regulation in Swedish schools

Sweden's educational system was, until the 1990s, characterised by strong state control and regulation of all aspects of schooling and a focus on providing a comprehensive programme as an antidote to schooling stratified by gender, class and future prospects. In terms of educational funding, there was a gradual shift during the 1980s to a semi-centralized funding system with more control of funding ceded by the state to the municipalities (Lundahl, 2002; SOU 2014:5, 2014; The National Agency for Education, 2009). This semi-centralized funding system was abolished in the 1990s and, from 1993, funding was devolved to municipalities in lump sums. The introduction of a nation-wide voucher system with the free choice of school caused schools to compete for students and a quasi-market was gradually shaped throughout Sweden (Böhlmark & Lindahl, 2007; Lundahl et al., 2013; Musset, 2012).

Following the decentralization of educational funding Sweden's total direct expenditure on primary and secondary education has remained comparable over the last two decades, standing at 7.5% of national expenditure in 1995 (OECD, 1999) and 7.7% in 2015 (OECD, 2018). However, since 1993 ring-fencing for school funding has been removed (Björklund et al., 2005), and how and in what areas of education this expenditure is utilized varies. Subsequently, "the amount of resources that schools receive (or allocate) for their operating budget (e.g. teaching material and supplies, maintenance of school buildings, preparation of student meals and rent of school facilities) is determined by the school in Sweden" (OECD, 1999, p. 296) and thus there is potential for between-school funding differences.

In addition to the decentralization of funding Sweden has experienced decentralization of educational decision making, with 66% of all decisions being made at the school level, compared to 13% at the national level in 1995 (OECD, 1999). In recent years, the school system has become more evenly controlled, with 21% and 35% of decisions made at the national and local level respectively

in 2015 (OECD, 2018). In tandem with this shift in the decision making structure the proportion of decisions related to the organisation of instruction made at school level has decreased from 88% in 1995 to 66% in 2015 (OECD, 1999, 2018). The independence of schools to make decisions regarding the organisation of instruction leaves open the possibility of potential for significant differences in the opportunity to learn (OTL) afforded to students in different schools and the development of an opportunity gap.

Consequences of the recent school reforms on educational equity

The introduction of school choice has been a cornerstone of the reformation of the Swedish educational system. Inherent to school choice has been the abandonment of the proximity principle, with students no longer compelled to attend their nearest school and the introduction of a voucher system allowing for funding to follow individual students. Furthermore, favourable conditions for the opening of independent schools which are independent of government control, operating as for-profit business, have become established in Sweden (Lundahl, 2002; Lundahl et al., 2013). Independent schools in Sweden are however subject to national rules on student recruitment practices and must be transparent in their application process and open to all (SFS 2010:800). In cases where schools are oversubscribed, while they may use approved criteria for selection (The National Agency for Education, 2016), academic selection or 'cream-skimming' in school admissions at the compulsory level is prohibited (Põder, Lauri, & Veski, 2017). Choice of school is limited somewhat by the uneven distribution of independent schools across the country and is in many cases "conditional on slots being available after those residing closest to the school had made their choices" (Böhlmark & Lindahl, 2007, p. 6; The National Agency for Education, 2016).

An increase in socio-economic and ethnic segregation between schools has been established in the literature (e.g. Söderström & Uusitalo, 2005; Yang Hansen & Gustafsson, 2016) following the introduction of the independent school and school choice policies, with housing segregation explaining the better part of between-school variation (Holmlund et al., 2014). Between-school segregation is reflected in increased between-school achievement gaps (The National Agency for Education, 2020a). Additionally, schools serving diverse and disadvantaged communities face difficulties attracting and retaining

teachers (Borelius, 2010; Möller, 2010) indicating entrenched social inequality in educational provision. A further concern in exploring Sweden's domestic achievement gap is its reflection in the findings of international assessments.

Swedish performance in international assessments

Since the turn of the millennium, international large scale assessments (ILSAs) have increasingly become the dominant metric for assessing school systems, providing rich streams of educational performance and contextual data (Gustafsson & Rosén, 2014; Nóvoa & Yariv-Mashal, 2003). This data can be leveraged to explore relations between contextual and systemic differences and academic outcomes at national and international level. Such inquires can include changing learning opportunities which have differential effects on equality and efficiency within school systems.

Sweden has a long and rich history of involvement with ILSAs, dating back to the 1950s and the earliest assessment surveys (Yang Hansen & Johansson, 2020). Sweden and Swedish researchers have long been involved with ILSAs, and the country has taken part in almost every student assessment conducted by the International Association for the Evaluation of Educational Achievement (IEA), which was for a time based in Stockholm (Yang Hansen & Johansson, 2020). Subsequently, data collected by the various IEA studies provides a fertile stream of evidence to assess changes in equality within Sweden over a prolonged period.

During the early part of the twenty-first century, Sweden witnessed a decline in student achievement across the board in international assessments including the OECD administered Programme for International Student Assessment (PISA) and the IEA run Progress in International Reading Literacy Study (PIRLS) and Trends in International Mathematics and Science Study (TIMSS). More recently published TIMSS 2015, PISA 2015, and PIRLS 2016 data suggest that Sweden is recovering from this prolonged period of declining school performance (Mullis, Martin, Foy, et al., 2016; 2017; OECD, 2016) which has been among the most severe in the OECD (Löfstedt, 2019). Despite the overall increase in Sweden's recent performance, the achievement gap has widened (e.g. Chmielewski, 2019). Worryingly in a study of 49 countries Sweden has experienced the most severe decline in achievement and socioeconomic equality of outcomes (Hanushek, Piopiunik, & Wiederhold, 2014). Sweden's fluctuating performance in international assessments and recurrent

achievement gaps provide scope to investigate inequality within an international context. When set against a backdrop of a transforming educational system, these evidenced inequalities are also ripe for contextualisation within the domestic sphere.

Chapter 3 Literature Review

This thesis draws on a number of key theoretical constructs in examining inequality in academic outcomes and opportunities. Chief among the concepts explored in this thesis is socioeconomic status as it forms the lens through which inequality is assessed. This chapter first establishes what is meant by socioeconomic status and the theoretical underpinnings of its measurement, before reviewing the literature surrounding the key constructs through which inequality is examined: opportunity to learn, school segregation and teacher characteristics.

Socioeconomic status

Socioeconomic status (SES) can be broadly described as ranking an individual or a family on a hierarchy according to their possession or control of commodities such as wealth, power, or social status (Mueller & Parcel, 1981). SES is perhaps the most commonly used contextual predictor of educational achievement, with a number of broad functions. SES can be used among other things as: a control variable to adjust for background differences in the sample, to stratify the data and increase the precision of comparisons between, for example, treatment and control groups, and an independent causal agent of educational outcomes (White, 1982). Additionally SES has a long and well-documented explanatory power within educational science (e.g. Coleman et al., 1966).

The theoretical structure of socioeconomic status

In order to grasp both the importance and the theoretical structure of SES it is pertinent to consider how families and their behaviour operate within the social space. The family is the central site of social interaction and the determinant of one's social position. The traditional definition of a family is a group of people bound together by marriage, blood, or adoption, who cohabit. The language used to define the family (i.e. home, household) confers upon objects the power to define the social relationship. The essential conception of the family, of a

group of people sharing a close legitimized social relationship and a home, defines a location for habitus. As Bourdieu (1998) summarises, the family is an anthropomorphic concept, which transcends the members of the group and requires the sublimation of individual identity to the collective. The family can be seen as a private, enclosed universe. The family unit is thus seen as an agent in itself, capable of making actions to its benefit.

Bourdieu asserts that the social space can be "constructed empirically by discovering the main factors of differentiation which account for the differences observed" (1987, p. 3). In such a constructed social world forms of capital can be identified which are useful in the struggle for resources within the social space. This social space is structured according to "the distribution of the various forms of capital, this is, by the distribution of the properties which are active within the universe under study – those properties capable of conferring strength, power and consequently profit on their holder" (Bourdieu, 1987, p. 4). SES is conceptualised by Bourdieu (1986) as having three facets: social capital, cultural capital, and economic capital. Simply put, children's social capital concerns family social connections and network, cultural capital includes family cultural and educational consumption, and economic capital measures family economic status. The division of a population into groups according to accumulations of the various forms of capital is practicable in so far as grouping individuals according to analytical constructs which are well-founded in reality allows us to define groups which are as similar as possible in as many ways as possible (Bourdieu, 1987).

A key assumption in the explanation of dominance by higher social classes of the strongest educational outcomes is that the educational system replicates the inherent advantages of higher social classes, such as advantaged parents simultaneously place greater value on education than their less advantaged counterparts and are better resourced to propel their offspring's achievement (Goldthorpe, 1996). However, such explanations are problematic as they fail to account for intergenerational changes in the meanings of cultural totems, "especially in the context of the social transformations engendered by advancing industrialism including major educational expansion and reform" (Goldthorpe, 1996, p. 488). Thus, a careful consideration of the measurement and structure of socioeconomic status and its' development over time is warranted if we are to integrate the concept into studies of educational inequalities.

Measuring SES

Socioeconomic status is fluid in as far as conceptions of social class and assignment to a class are heavily influenced by lived experience and exposure to the 'other' to which we relationally place ourselves. Given the aforementioned theoretical underpinning of the SES construct as encompassing multiple forms of capital, care should be taken when conceptualizing SES and "researchers should make an effort to use multiple components of SES in their operationalization because, when only a single component is chosen, the results are more likely to overestimate the effect of SES" (Sirin, 2005, p. 444). The measurement model of SES has long been considered tripartite (Sirin, 2005), typically including indicators of parental income, parental education, and parental occupation (Duncan, Featherman, & Duncan, 1972; Gottfried, 1985; Hauser, 1994; Mueller & Parcel, 1981; White, 1982). As education begets occupation and parental occupation is ordinarily correlated with income, these three parental indicators help draw a broad picture of the availability of Bourdieu's three strands of capital across socioeconomic groups (e.g. Duncan, 1961).

A broad trend, particularly in large scale international studies, is to substitute parental income for a measure of home resources (Cowan, Hauser, Levin, Beale Spencer, & Chapman, 2012; Sirin, 2005). The use of home possession items in large-scale data collection overcomes the practical obstacle of questioning adolescents about their parents' incomes while generating an indicator which covers both household income and the cultural and educational habitus of a family (Bourdieu, 1984; Bourdieu & Passeron, 1990). While neatly solving a data collection issue the choice of home possession items is not without implications. Home possessions can be argued to reflect parents' personal tastes (Magnuson & Duncan, 2006) or become totemic as an indicator of social status without considering the situational differences in their symbolism (Bourdieu, 1998) through uninterrogated reuse. In international studies incorporating countries across the economic and development spectra identifying key home possessions is further complicated by variations in abundance and scarcity of the chosen items between territories: items that indicate differential levels of wealth in one country are ubiquitous in another and items considered luxuries in one are basic infrastructure in another. An example of an approach countering this problem is The Demographics and Health Surveys (DHS), which utilizes the same survey instrument across more than 50 countries and is

seen to overcome the abundance/scarcity issue (Filmer & Pritchett, 1999), by examining housing characteristics rather than consumption as a proxy for household wealth.

The two principal institutions behind ILSAs in education, the OECD and the IEA, take substantially different approaches to measuring SES within their studies. In PISA the OECD computes the index of economic, social, and cultural status (ESCS). Three components – parental education, parental occupation, and home possessions – are used to compile ESCS through principal component analysis (OECD, 2017). The various components of ESCS have been subject to criticism for the validity threat due to inaccurate student reporting and weaknesses in the modelling of SES across countries (e.g. Rutkowski & Rutkowski 2010; 2013; Schulz, 2005). Despite these criticisms ESCS is a popular pre-complied measure of SES to use in secondary analysis of PISA data (Strietholt et al., 2019) and is provided for each cycle of PISA.

The approach taken by the IEA differs between studies. In the eighth grade section of TIMSS a consistent composite index of SES is not included. Over time TIMSS has asked students whether they have variety of home possession items. The only items to have appeared in every TIMSS cycle between 1995 and 2015 are the number of books in the home and a desk (Foy, 2017a; Foy, Arora, & Stanc, 2013b; Foy & Olson, 2009b; Gonzalez & Miles, 2001a; Gonzalez & Smith, 1997a; Martin, 2005a). A third item, a computer, has appeared in each cycle but was worded differently in the 2015 iteration (compare Foy, 2017a; Foy et al., 2013b). Recent cycles of TIMSS have included an index of Home Educational Resources (HER). This index is calculated from parental education, the number of books in the home and the number of home study supports (how many of 'an internet connection' and 'one's own bedroom' does a student have – 0, 1, or 2) and is expressed as a three point scale (many resources, some resources, few resources) (Martin, Mullis, & Hooper, 2016). A model for replicating HER across multiple cycles of TIMSS data tested by Broer et al. (2019) used two home possession items (a computer and a desk), parental education, and books in the home to model HER across 6 cycles of TIMSS (1995-2015) in 13 countries. The variance in mathematics achievement explained by their new SES variable highly correlated with that explained by HER in the 2011 and 2015 cycles.

In the absence of a pre-calculated SES measure, researchers conducting secondary analyses using TIMSS data must decide upon an appropriate measure of SES to use within their studies. The aforementioned variation in the number

of items deployed in the student questionnaire to indicate SES and the relatively few recurring items complicates this decision for researchers, particularly when investigating educational phenomena at multiple time points. A frequently observed practice for researchers in the field is to use a single item measure – commonly parental education or books in the home – to approximate SES or a combination of items to indicate the construct specific to their study (Strietholt et al., 2019).

SES and achievement

The long-standing predictive power of SES on achievement (e.g. Coleman et al., 1966) cannot be considered independently of the choice of approach to operationalising the concept. Composite measures of SES including PISA's ESCS have the strongest correlation with student achievement (Lee, Zhang, & Stankov, 2019). However there exist diverse approaches to operationalising SES in secondary analyses of ILSAs. When choosing to use a single-item indicator as a proxy of SES both the highest parental education (e.g. Schiller, Khmelkov, & Wang, 2002; Schlicht, Stadelmann-Steffen, & Freitag, 2010) and books in the home (e.g. Akiba, LeTendre, & Scribner, 2007; Ammermueller & Pischke, 2009; Luyten, 2017; Põder et al., 2017; Schütz, Ursprung, & Woessmann, 2008; Woessmann, 2005) are commonly seen. The rationale for distilling such a theoretically rich and multifaceted construct as socioeconomic status down to these single items requires a deeper examination of the cultural capital aspect of socioeconomic status and its relation to academic achievement.

Cultural capital exists in three forms: the objectified (i.e. cultural goods), the embodied (i.e. behaviours and activities) and the institutionalised (embodied cultural capital which is recognised and valued by the community, i.e. academic qualifications) (Bourdieu, 1986). The examination of these different elements of cultural capital and their relation to student achievement has been a long-running strand of enquiry within the educational sciences (e.g. De Graaf, De Graaf, & Kraaykamp, 2000; Kraaykamp & Van Eijck, 2010; Lareau, 1987). Tan's (2017) meta-analysis of the relationship between cultural capital and student achievement in 41 studies investigated the effect sizes of various indicators of cultural capital, representing Bourdieu's three facets of the construct. The findings of this meta-analysis indicated that institutionalised cultural capital in the form of parental education is the strongest predictor of student achievement, with a moderate effect size. The effect size of objectified

cultural capital in Tan's meta-analysis closely follows that of institutionalised cultural capital. These findings echo the results of previous meta-analyses (e.g. Sirin, 2005) which support home possessions and parental education as significant predicators of student performance and empirically justify the use of narrower measures of SES where necessary.

The predictive power of SES on achievement has also been evidenced at the collective (i.e. classroom and school) level. In their cross-national study of the multilevel dimensionality of SES and its relationship to reading achievement, Yang & Gustafsson found that "at the school level, a single factor (CapB), which is interpreted to represent the community's sociocultural and economic environment, is sufficient to explain the school-level SES variation" (2004, p. 278). Further to this they noted that "children from high income communities are more likely to attend high quality schools, and the peers with which they interact tend to have high educational and occupational aspirations (Brooks-Gunn, Duncan, Klebanov, & Sealand, 1993; Datcher, 1982)" (Yang & Gustafsson, 2004, p. 262).

The measurement and analysis of socioeconomic status is fundamentally tied to analyses of educational inequality as it forms yardstick with which equity and equality are measured. The concepts that are addressed in the remainder of this chapter are all indelibly linked to socioeconomic status.

Opportunity to learn

A sometimes nebulous concept, opportunity to learn (OTL) is examined across various strands of inquiry within the field of educational research, such as school effectiveness and educational equity. The importance of the opportunity to learn construct was laid out in Carroll's (1963) model of school learning, which posits that "the learner will succeed in learning a given task to the extent that [the learner] spends the amount of time that [the learner] *needs* to learn the task" (p. 725). In this model student learning is a function of time spent in learning over the time actually needed to learn content. The time spent learning comprises student perseverance or engagement with learning and the time allowed for learning. This time allowed for learning varies between teachers and programmes of study but may also be limited by an excess of material expected to be covered within a subject and is deemed to be opportunity to learn (Carroll, 1963).

While Carroll's model emphasises the time allocated to learning various content, the measurement of OTL has proven to be somewhat malleable, reflecting to a certain extent the purpose of the studies in which it is employed. Potential measures of OTL range from instructional factors such as content exposure or time on task, to curricula design, to contextual factors reflecting school environment or student-body composition (Martinez Fernandez, 2005). Given this flexibility, the selection of an indicator of OTL is of paramount importance to this thesis.

As a concept within international assessment, OTL has been developed as a measure of whether students have had the opportunity to study a topic within a subject (McDonnell, 1995). OTL is a key unifying concept in this thesis. As early as the late 1980s, Eggen, Pelgrum, and Plomp (1987) proffered the assumption that content exposure within a subject strongly influences student knowledge and that "students who are confronted with relevant subject matter in the classroom should - ceteris paribus - perform better than students who were not given the opportunity to learn the subject matter" (p. 134). Further, OTL has been shown to be a consistent predictor of achievement (see e.g. Marzano, 2003; Scheerens, 2017b; Scheerens, Luyten, Steen, & Luyten-de Thouars, 2007).

OTL has a difficult conceptual relationship to educational equality. Given common dialogues around the issue of educational equity which focus on compensatory programmes equality loses currency as a goal in delivering equity. When OTL for students is considered a matter of legal and social justice as a way to counterbalance the SES of their parents there is an implicit requirement for OTL to be unequally distributed across a population (Schmidt & McKnight, 2012). If we expect schools to compensate for students' backgrounds through the quality of education they provide then we can logically expect to see varying levels of OTL between schools located in differing social contexts: a school with a large cohort of students from disadvantaged backgrounds should implement programmes offering enhanced OTL compared to schools with students of mostly advantaged backgrounds.

Measuring OTL

The inclusion of items measuring OTL within current ILSAs derives from OTL's early inclusion as a technical concept designed to facilitate cross-national comparisons of performance. OTL has subsequently developed into a measure

of whether students have had the opportunity to study a topic within a subject (McDonnell, 1995). An early example of the measurement as content coverage by teachers within ILSAs comes from the IEA run Second International Mathematics Study (SIMS). Teachers were asked if they had taught the topics within the test, and if not whether those areas had been covered in the previous grade, were planned for the next grade, or were not planned to be taught within the school at all (McDonnell, 1995). In their analysis of Dutch results in SIMS, Eggen et al. (1987) investigated the relation between content coverage and the test-scores of participating students. While they found no substantial relation they did note statistically significant observed correlation between these two measures.

Carroll (1963) emphasized the importance of time allocated to learning content in his understanding and modelling OTL. This notion of allocated time has been refined over time in the literature to one of instructional time (e.g. Borg, 1980; Gettinger & Seibert, 2002), which has been shown to predict student achievement (e.g. Denham & Lieberman, 1980; Fisher & Berliner, 1985; Walberg, 1988). Instructional time, alongside content of instruction and instructional quality, is defined by Kurz (2011) as a key indicator of OTL in studies of the enacted curriculum. However time spent on task is not commonly included in measures of OTL in TIMSS. While all TIMSS cycles have asked teachers how much time is spent teaching mathematics to the class in a standard week, TIMSS does not consistently question teachers as to the proportion of time spent teaching the various subdomains of mathematics (Foy, 2017b; Foy, Arora, & Stanc, 2013a; Foy & Olson, 2009a; Gonzalez & Miles, 2001b; Gonzalez & Smith, 1997b; Martin, 2005b) making time on task difficult to account for in analyses of multiple TIMSS cycles.

Given the technical concerns of OTL's roots in ILSAs, studies including OTL as a measurable construct must also consider the national contexts in which they operate, as countries with centralised national standards are likely to be more prescriptive in how curricula are applied than in decentralised systems (Scheerens, 2017a). Therefore in cross-cultural contexts, constructs of OTL, while being captured using items that are worded consistently across territories might not be measuring the reality in each country. Simply put, countries and jurisdictions specify what students are expected to learn and teachers implement this to varying degrees within their own classes. A further challenge to measuring OTL is the need for exhaustive data collection. Teachers cannot be asked broad questions about, for example algebra or geometry, but instead need

to be given discrete questions for each concept and progression within the curriculum to build a representative measure[1].

As OTL is rooted in curriculum delivery (e.g. Porter & Smithson, 2001), whereby teachers implement (Schmidt, Raizen, Britton, Bianchi, & Wolfe, 1997) or enact (Porter & Smithson, 2001) national curricula goals, the role of teachers in the construct's measurement is important to consider. Teacher reports of OTL have been centred in the IEA's data collection procedures since the 1970s (McDonnell, 1995) and the use of such teacher self-reports to indicate OTL measures is supported by findings during the development of the Surveys of the Enacted Curriculum (SCE). The SEC were developed in the USA in the 1990s with the goal of creating a teacher self-reported survey instrument which provided reliable data relating to instruction (Blank, 2002). Notably, the SEC produced evidence of high correlation between surveys of taught content and written logs of teacher behaviour (Smithson & Porter, 1994) providing empirical support of the use of teacher survey derived measures of OTL.

OTL and achievement

Studies examining OTL on the individual level imply that the concept is a promising predicator of academic achievement. As Scheerens (2017b) summarizes, meta-analyses of school effectiveness variables have shown OTL to be a consistent predictor of achievement with average effect sizes (*d*-coefficient) of between .18 and .88 (see Marzano, 2003; Scheerens & Bosker, 1997; Scheerens et al., 2007). The positive relationship between OTL and student achievement in mathematics has been well established in the literature (e.g. Dupriez & Dumay, 2006; Fuchs & Woessmann, 2007; Gamoran, Porter, Smithson, & White, 1997; Reeves, 2012; Rowan, Correnti, & Miller, 2002; Schmidt, Cogan, Houang, & McKnight, 2011; Schmidt et al., 2001). These findings, and the consistency of OTL's predictive qualities give us cause to examine the construct further and consider how we might incorporate it into studies of educational equity.

Of particular influence in the formulation of OTL used in this thesis is the series of studies authored by Schmidt and his collaborators who theorized that variation in OTL may be due to curricula, instructional quality, and contextual differences (Schmidt, Zoido, & Cogan, 2013). In their study of the joint

1 For an example of the level of detail in TIMSS' OTL data collection instrument, see Appendix A.

relationship of OTL and socioeconomic status to student mathematics achievement using PISA data, Schmidt, Burroughs, Zoido, and Houang (2015) provide strong support for the prior work of Schmidt and McKnight (2012) which, as summarised, "argued for the existence of pervasive inequalities in OTL and hypothesized that part of the apparent role of SES was related to the systematically weaker content offered to lower-income students" (Schmidt et al., 2015, p. 380). The model is tested by Schmidt et al. regresses student achievement on SES and OTL and specifies a mediating effect of SES on mathematics achievement through OTL (specified as content coverage).

A weakness of the works of Schmidt et al. is the instrument and the level at which OTL is measured. PISA samples students within schools and collects data at student and school level. The OTL related items are measured by asking students how often they have heard of and how familiar they are with a concept (see OECD, 2012a, pp. 34-35). The OTL measure derived from these questionnaire items within PISA has been critiqued for confounding frequency of meeting topics and mastery of them. Further analysis has demonstrated that once self-concept is parcelled out from OTL and Schmidt et al.'s (2015) study is replicated, the effect of OTL on mathematics achievement is smaller, as is the indirect effect of socioeconomic status on achievement (Yang Hansen & Strietholt, 2018).

At the within-school level variations in OTL tell us something about the differing approaches to class assignment within and between schools in a system. Pronounced differences in OTL at the most granular level are observable in the United States, with students on different courses within a school receiving different curricula, rather than programme and track (in terms of academic or vocational) differences seen between schools in other countries (Cogan, Schmidt, & Wiley, 2001). Additionally the availability of multiple course choices can exacerbate existing socioeconomic inequalities by providing "incentives for students to structure their programmes in directions that are appealing and undemanding but that may ultimately be detrimental to their futures" (Lee & Bryk, 1988, p. 92).

In addition to the legal requirements for transparent and open application processes (SFS 2010:800), a crucial feature of the Swedish school system is that at compulsory level (ages 6-16) it does not allow for academic selection with guidance explicitly stating that schools may not use tests or exams in the selection and admission of students (The National Agency for Education, 2016). In such a system with both a strong centralised curriculum and an

absence of tracking we might assume lower within-school variations of OTL and higher between-school differences. In light of the comprehensive nature of the Swedish compulsory school it is essential to consider additional factors which might drive between-school variation in OTL, principally segregation.

OTL and school segregation

A final factor influencing OTL that needs exploring is school composition. OTL has long been linked to equity issues (Guiton & Oakes, 1995; McDonnell, 1995). If OTL has a role in educational justice, then "it hurts the idea of educational justice if OTL distribution depends on the students' socioeconomic and cultural status and if less beneficial OTL is offered to less privileged students, while more privileged students are exposed to more challenging content or goals" (Lafontaine, Baye, Vieluf, & Monseur, 2015, p. 2). OTL alone explains less than 10% of between-school differences in achievement on average across OECD countries. However, in conjunction with SES it explains nearly 30% of between-school differences, reflecting "the overlap between the predictors in explaining the school average performance in reading, corresponding to the fact that OTL are not independent from school social intake" (Lafontaine et al., 2015, p. 7). It has been suggested that in planning for mathematics teaching, "teachers expect mixed and predominantly minority classes to have less previous exposure to these topics, warranting treating more topics as new material, yet simultaneously holding lower expectations for students mastering the content" (Guiton & Oakes, 1995, p. 330), implying that the composition of a school's intake can have profound implications for the OTL afforded to students.

School segregation in Sweden

Internationally the exploration of the distribution of students to schools has had a rich tradition in the literature since the publication of the landmark Coleman Report (Coleman et al., 1966). It is well established that students from deprived neighbourhoods will have lower educational attainment than those from affluent areas (Entwisle, Alexander, & Olson, 1994; Gephart, 1997; Mayer, 2002). In the Swedish context social and ethnic segregation is a key contemporary concern (Kornhall & Bender, 2018).

Residential segregation in Sweden begets educational segregation (Lindbom, 2010), with children from marginal neighbourhoods being offered lesser

educational opportunities than their contemporaries from advantaged neighbourhoods (Beach & Sernhede, 2011). Additionally recent evidence suggests that residential segregation in Sweden varies between municipalities with those with lower populations exhibiting higher levels of social mixing within schools (e.g. Malmberg & Andersson, 2021). The effects of segregation in schools are not uniform across Sweden. In regions with large visible minority populations student achievement in mathematics varies significantly between schools to a greater extent than in those with low minority populations with socioeconomic background only partly explaining this between-school variability (Andersson, Östh, & Malmberg, 2010). The existence of residential and educational segregation in Sweden reflects the conclusions of international scholarship in the field. Generally residential segregation has been linked to increased achievement gaps between socioeconomic groups, with high-income students performing better than their low-income peers in more-segregated places (Owens, 2017). When school attendance is closely linked to residential proximity children in (both economically and ethnically) advantaged neighbourhoods attend better schools and mix with classmates who have high educational and occupational aspirations (e.g. Brooks-Gunn, Duncan, Klebanov, & Sealand, 1993; Datcher, 1982).

School segregation and school choice

In line with other European educational systems that have introduced school choice and experienced increasing levels of school segregation (e.g. Agirdag, Van Houtte, & Van Avermaet, 2012), Sweden has seen a growth in segregation in lockstep with changing patterns of school enrolment. Segregation between schools has developed from being defined by residential segregation prior to the introduction of school choice, to being much more determined by social background (Böhlmark, Holmlund, & Lindahl, 2016). Studies of social context and school choice in Sweden suggest increased segregation along ethnic and achievement lines, particularly in large cities and their suburbs (Andersson et al., 2010; Yang Hansen & Gustafsson, 2016). In urban areas of Sweden students from visible minorities attend schools closer to their residence while in ethnically mixed neighbourhoods, Swedish-born and non-visible minorities have higher travel to school distances, indicating that they are opting out of local schools (Andersson, Malmberg, & Östh, 2012), coinciding with prior findings that use of school choice policies itself is socially segregated (Teske &

Schneider, 2001), and evidence that choice engenders educational segregation beyond the levels inherent in a residentially segregated context (Böhlmark et al., 2016).

School segregation and teacher recruitment

Additional effects of school segregation are observed when we consider teacher recruitment. Evidence from English speaking countries suggests that students in schools that are characterised as having low-SES, high migrant populations, or low attainment are more likely to be taught by non-specialist teachers (Peske & Haycock, 2006), and that students in socioeconomically disadvantaged schools are twice as likely as those in advantaged schools to have unqualified teachers (Allen & Sims, 2018). To fully understand the implications of the inequitable distribution of quality teachers in segregated schools this review now turns to teacher characteristics and the construct of teacher quality.

Teacher characteristics

Teacher quality, also expressed as teacher qualification and teacher competence is widely acknowledged to correlate with student achievement (e.g. Baumert et al., 2010; Darling-Hammond, 2000; Goldhaber & Brewer, 2000; Johansson, Myrberg, & Rosén, 2015), and can explain substantial variance in student achievement (Nye, Konstantopoulos, & Hedges, 2004). The academy does not define a single marker of teacher quality with several teacher characteristics argued for in the literature. One approach to synthesising the various strategies for defining teacher quality is Goe's (2007) framework of teacher quality. In this framework, Goe groups the various measures of teacher quality in the literature into three areas: inputs, processes, and outcomes. The first of these strands, inputs comprising teacher qualifications and characteristics, is considered of the greater relevance to this thesis (the second and third strands of teacher quality measures that Goe conceptualises (processes and outcomes) are conceptualised respectively as teacher practices and student gains in achievement). Broadly, teacher qualification has been defined as length of service and possession of formal qualifications. More experienced teachers are considered more employable by school administrators (Place & Vail, 2013), and indeed the students of more experienced teachers slightly out-perform their peers with more junior instructors (e.g. Cavalluzzo, 2004; Clotfelter, Ladd, & Vigdor, 2006).

In the literature a positive relationship between subject-specific preparedness to teach and students' mathematics achievement has been established (Caceres, 2009). Yetkiner Özel & Özel found that in Turkish schools, while "teachers' self-reported preparedness in content domains of number, algebra, geometry, and data-and-chance was not found to be related to eighth-grade students' mathematics achievement" (2013, p. 240), there was a discrepancy in the distribution of high quality teachers among different social groups. In international comparison access to qualified mathematics teachers has been shown to vary between different social groups, with high-SES students more likely to have qualified teachers than their low-SES peers.

The distribution of qualified teachers is not uniform across countries. While countries including Chile, Taiwan, and the USA displayed large opportunity gaps in access to qualified teachers indicating social inequality in the distribution of mathematics teachers, Sweden demonstrated a smaller "needs-based" access gap to qualified mathematics teachers with 3.7% more low-SES students taught by qualified teachers than their high-SES peers (Akiba et al., 2007). This compensatory distribution of qualified teachers in Swedish schools may be at odds with the pattern established in similar economies by Akiba et al. (2007), however it is prescient to also consider the regulatory framework surrounding teaching in Sweden.

The academic history of teachers particularly in terms of mathematics coursework at university has a positive association with mathematics performance among older students (Rice, 2003; Wayne & Youngs, 2003). In the Swedish context the amount of mathematics content studied by teachers has been shown to have a positive association with their classes mathematics achievement. However this does not appear to mediate the effect of student background on achievement (Toropova, Johansson, & Myrberg, 2019). It is worth considering that teaching is a licenced profession in Sweden requiring completion of a bachelors level degree programme in teaching. Formal teacher education must additionally be verified by the National Agency for Education for a teacher to be permanently employed. Teacher verification is anchored to subject specialism and the age-group a teacher is trained to teach (SFS 2011:326). Given this structured regime for teacher validation it is perhaps reasonable to expect less variation in teacher qualification and a smaller effect on student outcomes than other teacher characteristics.

As prominent stakeholders in the educational process (alongside school administrators, parents, and students), teachers contribute to the climate of the

schools they work in (Anderson, 1982). School climate is a contributory factor to students' academic outcomes (e.g. Esposito, 1999; Haynes, Emmons, & Ben-Avie, 1997) and may counter the negative consequences of socioeconomic background on achievement (e.g. Astor, Benbenisty, & Estrada, 2009; Haahr, Nielsen, Hansen, & Jakobsen, 2005). Teacher qualification correlates with school climate (e.g. DeAngelis & Presley, 2011), while poor school climate relates to lower teacher retention rates (Ingersoll, 2009). Furthermore "a positive school climate promotes cooperative learning" (Thapa, Cohen, Guffey, & Higgins-D'Alessandro, 2013, p. 365), improving the learning environment overall and a number of studies suggest that there is a strong relationship between school SES and a positive school climate (see Bryk & Raudenbush, 1988; Hoy, Tarter, & Hoy, 2006; Thapa et al., 2013). The interplay between school climate and achievement, and the professional contribution of teachers to establishing a good school climate, can be viewed as an embodied expression of teacher characteristics and is therefore worthy of contemplating alongside teacher qualification as a mode understanding educational inequality.

Chapter 4 Theoretical Framework

This thesis builds on earlier theoretical and empirical research on the nature and structure of several key concepts, namely socioeconomic status, opportunity to learn, and the interactions between these constructs and with achievement. The theoretical framework of this thesis is constructed in two stages. Firstly the key concepts are bounded together within the theoretical framework of the TIMSS Model of Potential Educational Experiences (Schmidt et al., 1997). Secondly the TIMSS Model of Potential Educational Experiences is considered through the lens of social reproduction.

The TIMSS model of potential educational experience

Since the earliest days of educational science curriculum has been considered experiential (Bobbitt, 1918; Dewey, 1902), consisting of a series of activities or experiences that students must progress though in school on the path to adult life. While the individual is core to this early understanding of curriculum as a pathway of experiences, education is by necessity a grouped endeavour with students placed within classes and classes operating within schools. Consequently curriculum must reflect common goals for experience across the participants in the educational project.

TIMSS, alongside other studies conducted by the IEA, considers curriculum to be a complex and multifaceted construct with the TIMSS Model of Potential Educational Experiences (as summarised in Figure 1), illustrating educational experience as a delicate web of multi-level relations between aims, actors, and choices across systems, classrooms, and individuals (Schmidt et al., 1997). This theory is rooted in the 1995 TIMSS International Curriculum Analysis (ICA). The TIMSS ICA applies a Tri-Partite Model of Curriculum to analysis of the curricula frameworks and textbooks present in participating countries. This Tri-Partite Model conceptualises curricula as existing across three levels, the systemic, the classroom, and the student (e.g. Houang & Schmidt, 2008).

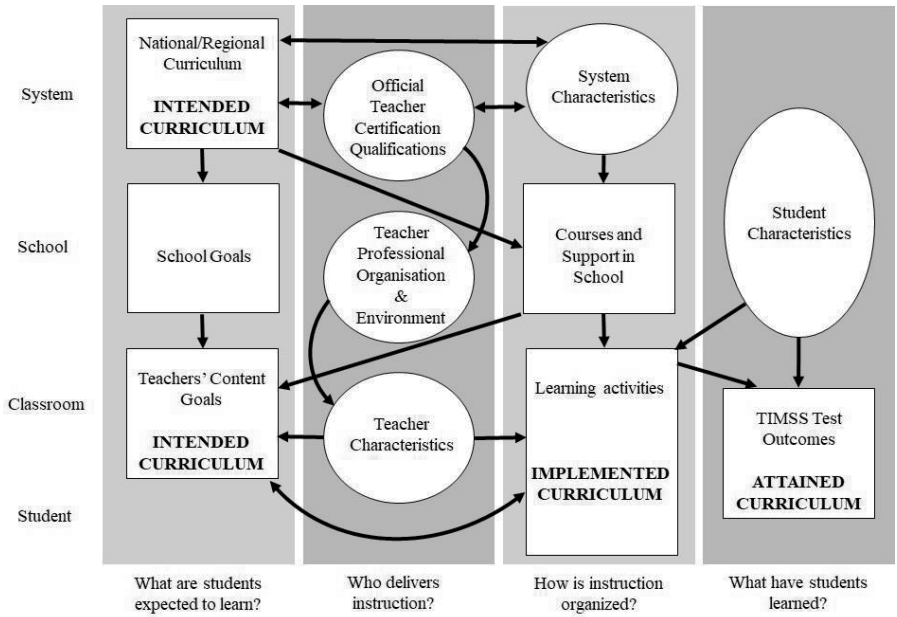

Figure 1 Theoretical model of educational experiences

(based on Schmidt et al., 1997)

Firstly, on a systemic level, curricula are intended. The intended curriculum is officially sanctioned and is generally policy driven at the national or sub-national level. This iteration can reflect cultural values and societal priorities, and is the metric against which schools may evaluate their provision. Next within classrooms the implemented curriculum is planned and delivered by teachers. Finally, the attained curriculum exists at the student level and is an outcome of the implemented curriculum (Houang & Schmidt, 2008; Schmidt et al., 1997). Simply put countries and jurisdictions specify what students are expected to learn, teachers implement this to varying degrees within their own classes, and students individually engage with and implement the learning made available to them. The sum of these actions is then quantified by, among other instruments, international assessments.

To the model of potential educational experiences shown in Figure 1, it is expedient to add an additional pathway to emphasise the role of TIMSS in defining our understanding of educational experiences. At the systemic level the intended curriculum is manifested as national curricula. These country or territory specific curricula are then drawn upon by the IEA to create the framework of knowledge and skills assessed in TIMSS (e.g. Mullis, Martin, Foy,

et al., 2016). It is from this framework that the implemented curriculum is measured, particularly in terms of instructional activities and progression though topic areas. In integrating TIMSS into the framework of potential educational experiences as an institutional actor the attained curriculum that is measured by TIMSS reflects a curriculum that is limited by the common knowledge and skills framework, rather than the full scope of experience afforded within the classroom context.

Educational experience and opportunity to learn

Assessing student performance in relation to educational experience in a multi-national setting requires some pragmatic considerations. Cross-national comparison of intended curriculums must take into account multiple systemic factors including school start age, whether school systems are tracked or comprehensive and delegation of curricular control (notably Canada, the USA, and Germany are core TIMSS participants with education controlled at a subnational level (Mullis, Martin, & Loveless, 2016)). Thus within-system variation in intended curriculum may vary substantially between, for example, the Swedish comprehensive school model and the German federated and tracked model of education. Deciding which aspects of the intended curriculum are common across educational systems within a particular grade is a core task of the assessment framework developed by TIMSS in conjunction with national research centres and updated between study cycles to reflect changing priorities in terms of expected skill and content development (Mullis, Martin, & Loveless, 2016).

The implemented curriculum is a moderating relationship between the intended and achieved curriculum. As an expression of the desired experiences laid out by the intended curriculum, the curriculum manifested at classroom level can be termed opportunity. All choices made at the school and classroom level (i.e. how students are grouped, how the timetable is built, which resources are bought) have implications for opportunities. Common educational opportunities are bounded by time with finite time available to cover the multiple activities and areas of knowledge recommended at the systemic level.

Understanding the distribution of educational opportunities is key for contextualising and understating the attained curriculum and student achievement, as well as achievement gaps. Schmidt et al. (1997) note that the assumption that students will test better on topics and content that they have

been taught than those they have not (e.g. Eggen et al., 1987), has long been conceptualised as opportunity to learn (OTL) in IEA studies. As expanded upon in Chapter 3 of this thesis, the OTL construct has evolved from a cross-national comparator of performance to encompass the implemented curriculum (McDonnell, 1995). However through the lens of the TIMSS Model of Potential Educational Experiences the OTL measure in TIMSS could best be considered as the culmination of choices made at the national, school, and classroom level which determine the opportunities offered to students.

Educational experience and social reproduction

The student level inputs to the TIMSS Model of Potential Educational Experiences (defined as "student characteristics" in Figure 1) feed in to both the attained curriculum and the implemented curriculum. Accordingly it is essential for us to consider potential educational experience in the context of students' social origins. The role of student background in education is here explored through the theory of social reproduction.

The theory of social reproduction posits that education contributes to reproduction of power relationships between social groups (Bourdieu, 1971). It has been suggested that schooling has functioned as a venue for social reproduction since antiquity (e.g. Guillory, 2013; Lloyd, 1990). Despite twentieth century shifts from explicitly socially reproductive schooling to a meritocratic system the link between student background and achievement was not eliminated (Coleman et al., 1966; Jencks et al., 1972). Throughout the latter half of the twentieth century researchers conducted reproduction analyses across many educational contexts, applying economic, cultural, or linguistic lenses (Collins, 2009). While this strand of analysis fell out of vogue by the turn of the millennium (Collins, 2009), the persistent link between socioeconomic status and achievement in the literature (e.g. Marzano, 2003; Scheerens & Bosker, 1997; Scheerens et al., 2007) underscores the link between student background and experience within educational settings.

Bourdieu (1998) frames discussion of social reproduction in education in terms of university admissions. The pinnacle and some might say goal of the education system, university entrance can be read as the final step in compounding the link between family origins and eventual social status by rewarding high achievement, and facilitating access to high status and financially lucrative employment fields. In doing so the end goal of academically orientated

education programmes diminishes the effects of supposed meritocracy in education. Rather than rewarding individual aptitudes the confabulation of social background and student achievement through the educational system creates a layer of reproduced privilege that is legitimized by academic qualifications (Bourdieu, 1998).

When family is given the central role in defining an individual's location in the social space and likely pathway through the educational system deviation from the route defined by the family's position in the hierarchy requires deliberate action. Any such movement through a socially ordered system requires a certain amount of capital, either economic, so as to make the often costly process of removing oneself from a given locale, or cultural. The expression of economic capital as a facilitator of movement in the educational system can be conceptualised as the movement from one neighbourhood to another for the purpose of accessing 'better' schooling opportunities (e.g. Bernelius & Vilkama, 2019). Cultural capital is necessary for making the judgements facilitating a move through the social space. Such a movement requires the interrogation and internal deliberation of the process between the structure being moved through (i.e. the educational system) and the agency required to do so (Archer, 2003). These movements at the individual level interact with the educational opportunities expressed at the classroom level of the TIMSS Model of Potential Educational Experiences. The behaviour of the student's family in selecting a school, whether by actively seeking more favourable educational environs or by passively accepting the designated one, can have implications in the opportunities afforded to students and the actualisation of social reproduction within the school system.

Concluding remarks

Across the consistent papers in this thesis elements of curricula expectations, delivery, instruction, and outcomes are examined from the system, classroom, and student levels. As the primary site of the thesis is Sweden, consideration of a comprehensive model for education is foregrounded by deliberately excluding system characteristics in instructional organisation (i.e. tracking) from the analyses at both the national and international levels. Familial socioeconomic status is considered as both a metric by which inequality of outcomes is identified and a variable facilitating further inequality in opportunities. The operationalisation of SES varies between the constituent studies. In Study I, the

creation of an optimum model of SES for Sweden generates space in which to discuss the appraisal of such an intangible yet fundamental construct. Alternative measurements of SES are applied to facilitate the exploration of inequalities in education across the international (Study II) and national (Study III) contexts. Study II and III in this dissertation explore equality in the implemented curriculum through content coverage and opportunity provided at the classroom level. As the chief actors in curriculum implementation teachers and their characteristics are integrated into the model of educational equity in Sweden in Study III.

Chapter 5 Methodology

In this chapter the data used within the thesis is presented. The analytical methods used are discussed, as are the implications of data and method choices on the validity and reliability of the thesis.

Data

This thesis is based on data collected and published as part of two International Large Scale Assessments (ILSAs): the Trends in International Mathematics and Science Study (TIMSS) which is implemented by the International Association for the Evaluation of Educational Achievement (IEA), and the Organisation for Economic Cooperation and Development (OECD) run Programme for International Student Assessment (PISA). The decision to utilise data from both the PISA and TIMSS suites of studies is driven by the nature of the data available, the level of data collection, and the empirical aims of the constituent studies.

International large scale assessments

TIMSS measures student achievement in mathematics and science at the fourth and eighth grade level and has operated on a four year cycle of assessment since 1995. Participating countries can choose whether to enter students into either or both of the fourth and eighth grade studies. The aim of TIMSS is to aid countries in making "informed decisions about how to improve teaching and learning in mathematics and science" (Mullis, Martin, Foy, et al., 2016, p. 2). The assessment frameworks evaluated by TIMSS are created in collaboration with the various participating countries, and as such reflect the common curricular goals for student content knowledge and cognitive processes (Mullis, Martin, Foy, et al., 2016). This curriculum-based framework is married with contextual data gathering and analysis to create a dataset that can be used to appraise national goals, standards, and achievement in an international context.

PISA has run on a triennial basis since 2000 and takes an age-based approach to assessment by testing 15-year-old students, with the goal of assessing "the

extent to which they have acquired key knowledge and skills essential for full participation in social and economic life" (OECD, 2019, p. 26). Administered by the OECD, participation in PISA was initially focused on member economies and a smaller number of partner (non-OECD) countries. In subsequent cycles the number of partner countries participating in PISA has expanded substantially with more partner countries than OECD member countries participating in the 2018 cycle (OECD, 2019). Underpinned by the expectation that participating students should apply knowledge in new situations rather than reproduce what they have learned in school (OECD, 2019), PISA assesses literacy across reading, mathematics, and science. While each cycle of PISA has a primary focus that takes up half of the available testing time, which rotates between domains with each cycle (reading in 2000, 2009, and 2018; mathematics in 2003 and 2012; and science in 2006 and 2015), competence is also assessed in the minor domains. As with TIMSS the PISA dataset provides measurement of student performance with contextual data related to both home and school influences on learning.

In addition to the differing academic focus and age groups targeted by TIMSS and PISA there are differences in the sampling approaches these two studies use. The TIMSS sample available for use in these analyses was drawn according to the process laid out by IEA. The sample was identified according to TIMSS's basic sample design: a stratified two-stage cluster sample design, the first stage of which selects schools and the second, one (or more) classes within the school (Martin et al., 2016). Participating countries may specify stratification variables in their sample. As an illustration of the country-specific stratification process, the Swedish sample for TIMSS 2015 for grade eight is explicitly stratified by grade average (Martin et al., 2016). The IEA notes that "for most countries, the TIMSS precision requirements are met with a school sample of 150 schools and a student sample of 4,000 students for each target grade" (Martin et al., 2016, p. 3.9), and the Swedish sample for 2015 includes some 4090 participants. It is important to note that TIMSS relies on the precision of its sample, and for national samples to be deemed acceptable for the study, very high minimum participation rates are required at all sample levels (Martin et al., 2016). In using a sample drawn under the procedures outlined by the IEA in the TIMSS methodology, we can expect a sample from which inferences can be generalised to the national population at that age level.

The PISA studies have a similarly rigorous sampling procedure (see, for example OECD, 2014), with a two stage stratified sampling design. The first

stage of the design samples schools in which 15 year old students are enrolled, with the probability of a school being sampled proportionate to the number of 15 year olds enrolled. The second stage of the sampling procedure samples students within schools, with a target cluster size of 42 students per sampled school (OECD, 2017).

The methodological choice to use data from both TIMSS and PISA in this thesis was motivated by both the aims of each constituent study and the designs of the two ILSAs. The goal of Study I to build a measure of SES over time required the use of PISA data due to that dataset's expansive and consistent data collection regarding SES. The aim of examining the relationships between SES, OTL, and achievement at multiple time points in Study II necessitated the use of TIMSS data as the cyclic nature of PISA's domains provides limited time points for assessing these relationships within a single domain. The integration of teacher characteristics in Study III provided the rationale to use TIMSS data in this study, as the individual rather than class sampling in PISA does not provide sufficient data regarding teaching practice. The use of TIMSS in Study II and Study III also provides for considering inequality at the classroom level within this thesis, as while students may be segregated between schools on a variety of characteristics (i.e. socioeconomic status, ethnicity, or prior achievement), they might also be segregated into classes for various administrative or pedagogic purposes and it is at the classroom level where curriculum is implemented and opportunities can differ. The constituent studies in this thesis draw on data representing a large number of students and teachers. Study I incorporates data representing 26,043 Swedish students across six cycles of PISA. Study II uses TIMSS data from the 2003, 2007, 2011, and 2015 iterations. A total of 965,029 students in 40,051 mathematics classrooms and 936,964 students in 39,156 science classrooms are used in the study (for a complete accounting of countries and participant numbers, see Rolfe, Strietholt, & Yang Hansen, under revision, Appendix A). Study III analysed TIMSS 2015 data concerning 3,888 students taught by 190 mathematics teachers in Sweden.

Operationalising constructs

Student achievement is used as the dependant variable in Study II and Study III. Due to the thematic breadth and varying levels of ability that are evaluated within the TIMSS assessment it is not possible for students to be tested on everything. TIMSS uses a matrix-sample design to administer a subsection of

the total test item pool to each student. Item Response Theory is subsequently applied to student responses to estimate achievement. This approach allows a narrow range of individual responses to be aggregated across the whole sample to cover the full range of topics within the assessment and to estimate achievement (Martin et al., 2016). Rather than producing a single achievement score, the TIMSS dataset provides five plausible values "to ensure the accuracy of estimates of the proficiency distributions for the TIMSS populations as a whole and particularly for comparisons between subpopulations" (Martin et al., 2016, p. 12.17). All five plausible values must be integrated into models using achievement in TIMSS data in order to accurately estimate models (Martin et al., 2016).

Despite the use of science achievement to replicate analyses within Study II, mathematics achievement is the key subject domain in this thesis. The focus on mathematics reflects the fact that mathematics has been recognized since at least the mid-1970s as the academic domain least affected by home and background characteristics and most influenced by schooling and school processes (Murnane, 1974). Furthermore mathematics exhibits a greater level of conformity and agreement between systems. Unlike language arts there should not exist differences in the fundamental structure of mathematics between counties: a fraction is a fraction is a fraction, regardless of the language of instruction.

Independent variables used in this thesis are derived from the contextual data collected in the PISA student questionnaire and the TIMSS student and teacher questionnaires. The two principal independent variables used in this thesis, SES and OTL, are operationalised in several ways across the constituent studies. Study I uses PISA student questionnaire items relating to home possessions and family background, specifically a desk, a dedicated study space, books to help with school work (textbooks), educational software, a room of one's own, a domestic internet connection, classical literature, poetry, works of art, the number of books in the home, and the highest parental education level, to construct a measurement model of socioeconomic status. The choice to use PISA data in this study was motivated by the large number of repeated items across the various cycles of PISA from which to build a model. The PISA dataset includes 24 defined possession items across the 6 cycles, with the option for participating countries to specify an additional 3 country specific items indicating wealth from the 2003 cycle onwards (Adams & Wu, 2002; OECD,

2005, 2009, 2012b, 2014, 2017). Of these items, 11 appeared in each cycle of PISA, alongside indicators of parental education and parental occupation.

As discussed in the Literature Review chapter of this thesis the number of items indicating SES in the TIMSS datasets is limited. Twelve home possessions items are included in the TIMSS datasets between 2003 and 2015, of which books in the home, and a desk appear consistently worded, and a computer appears in different forms (Foy, 2017a; Foy et al., 2013b; Foy & Olson, 2009b; Martin, 2005a). This scarcity of repeated items is the motivation for using a single item, books in the home, to indicate SES in Study II. Books in the home was chosen as the indicator has previously been shown to distinguish between culturally advantaged and disadvantaged groups (Yang Hansen & Munck, 2012). Conversely as Study III is limited to a single country within single cycle of TIMSS, it was possible to draw on a broader range of questionnaire items (i.e. books in the home, parental education, and home possessions) to indicate socioeconomic status as a latent variable.

As the mathematics and science content within TIMSS's assessment framework has evolved over time so to have the items used to measure content coverage in the teacher questionnaire. Consequently the number of items used to indicate content coverage varies across the TIMSS cycles (for an overview of the items used within the mathematics and science OTL parcels, see Appendix A). To account for this variation in the number of items (indeed only 9 and 16 items appear across the 2003-2015 TIMSS cycles for mathematics and science respectively), in Study II cycle specific items are used to create a parcelled OTL variable. Study III's single cycle scope allowed for modelling OTL as the latent construct content coverage indicated by parcels representing the four subdomains of mathematics (algebra, number, geometry, and data and chance).

Corresponding to the conception of SES and OTL, Study III models teacher quality as a latent construct, with teacher quality indicted by years of teaching experience and preparedness to teach across four subdomains of mathematics (the items indicating which are detailed in Appendix B). Additionally Study III includes a latent construct indicating teacher perceptions of school emphasis on academic success and conducts grouped analysis, with the groups defined by whether a teacher is a mathematics specialist or not (as defined in Rolfe, Yang Hansen, & Strietholt, under revision).

Analytical methods

A popular approach in applied research in the social and educational sciences, structural equation modelling (SEM), is a family of statistical methods for exploring the relationships between variables which forms the key analytic approach taken in this thesis. SEM allows researchers to establish measurement models, investigate the relations between theoretical constructs (latent factors) and manifest variables using regression analysis, and to specify complex paths between dependent and independent variables (Hox & Bechger, 2007), and is capable of modelling relations across multiple levels of data (Hoyle, 2012).

The analyses within this thesis were conducted using Mplus (Muthén & Muthén, 1998-2017). Data was cleaned and prepared using SPSS. A powerful analytic programme, Mplus allows for multivariate, multi-level statistical models with and without latent variables within a single framework (Muthén & Muthén, 1998-2017), making it particularly suitable to the enquiry within this thesis.

Establishing measurement models

Many of the concepts investigated in educational science are not directly observable. To integrate these concepts into a statistical understanding, instrumentalisation and handling of data is key. Establishing a measurement model is foundational to studying educational phenomena measured using multiple items. In the case of non-cognitive domains such as socioeconomic status and OTL, confirmatory factor analysis (CFA) is a particularly useful approach. CFA is rooted in the common factor model, which allows researchers to "determine the number and nature of latent variables or *factors* that account for the variation and covariation among a set of observed measures, commonly referred to as *indicators*" (Brown, 2015, p. 10). In this way the common factor model reduces the complexity of modelling with a large number of indicators by identifying one or more common underlying factors. The unobserved, or latent, factor explains intercorrelation in the observed items from which it is comprised. By reducing a larger number of observed variables to a smaller number of factors a more parsimonious interpretation of the relationship between indicators is possible (Brown, 2015).

CFA is a highly theory driven framework and in order to apply CFA, the researcher should have a strong a priori sense both that latent factors exist in the data and that the observed variables be related to a specific factor (Brown, 2015). In the case of ILSA data, the repeated grouping of items within

subsections of questionnaires and the documented use of groups of items to create indices (e.g. Martin et al., 2016; OECD, 2017), can give researchers cause to believe that groups of items indicate the same construct.

CFA is a strong framework in which to compare measurement models across groups (i.e. between cohorts at different time points or grouped by a certain characteristic) through multiple group confirmatory factor analysis (MGCFA). MGCFA builds on the strengths of the CFA framework by integrating multiple groups in a single model. Such a multiple group approach enables all potential aspects of invariance to be examined and provides evidence of comparability across time (Brown, 2015; Cheung & Rensvold, 2002). A final advantage to applying CFA to ILSA data is that the CFA framework is rather flexible and allows for the examination of partial invariance (Byrne, Shavelson, & Muthén, 1989).

When modelling latent phenomena across multiple cohorts a well-fitting MGCFA model is not by itself sufficient to validate the measurement model across the groups. In these instances measurement invariance (MI) testing is necessary. MI testing involves a stepwise progression through a series of models, testing for identical factor structure (configural invariance), equality of factor loading (metric invariance), and equality of indicator intercepts (scalar invariance). Establishing measurement invariance at all three levels is essential for the unambiguous assessment of between-group differences in a latent construct (Cheung & Rensvold, 2002), and is foundational for making legitimate comparisons between cohorts.

When faced with a measurement model for which scalar invariance cannot be established the alignment optimisation approach is an alternative method for ascertaining whether a measurement model is trustworthy. A flexible methodology, the alignment method allows for comparison and assessment of measurement equivalence across of large numbers of groups and subgroups within populations (Asparouhov & Muthén, 2014; Munck, Barber, & Torney-Purta, 2017). The application of the alignment analysis to ILSA data is a small but growing area of the literature (see Glassow, Rolfe, & Yang Hansen, 2021; Munck et al., 2017). The alignment model can be used in analysis of invariance providing information about the degree of measurement invariance in addition to "the primary goal of the alignment [which] is to provide a comparison of factor means and factor variances across groups while allowing for approximate measurement invariance" (Asparouhov & Muthén, 2014, p. 499). Invariance analysis for factor indicators is useful as it allows for the identification of the

most invariant variable which can be excluded from the measurement instrument through a process of refinement, or be in turn used as an anchor in further multiple-group confirmatory factor analysis (Asparouhov & Muthén, 2014). Alignment analysis builds on the configural model, and individually estimates factor mean and variance for each group while simultaneously discovering the best-fitting pattern of measurement invariance (Asparouhov & Muthén, 2014).

Structural equation modelling

An advantage of the SEM framework is that it allows researchers to model complex relationships between observed variables (both latent and manifest). Path analysis enables researchers to use a variable in multiple regressions simultaneously, by specifying a variable as dependent in one relationship and independent in a second. In this case the variable mediates the relationship between the independent and dependent variables in these relationships and draws an indirect path between them (Muthén & Muthén, 1998-2017). Path analysis is applicable in the analyses of equity in this thesis as it permits, for example, OTL to both predict achievement and be predicted by SES (see Study II). It is possible to specify the calculation of the indirect effect of SES on achievement through OTL and draw inferences as to how OTL might perpetuate the inequality in the direct SES-achievement relationship.

Multilevel modelling is used within SEM to evaluate hierarchical data (Hox, 2002). The analyses in this thesis use achievement as an outcome variable to investigate achievement gaps. Multilevel modelling allows achievement, which is indicated at the student level, to be used at both the student and the class level in order to ascertain how much of the total variance in achievement is attributable to each level of the analysis. This decomposition of the total variance in the outcome enables the examination of factors that account for the variance at respective levels simultaneously by providing model estimates at two levels.

TIMSS data is considered complex survey data due to its sample design therefore there are a number of issues which should be addressed when applying the SEM framework to generate accurate estimations. As mentioned in an earlier section of this chapter, TIMSS uses a stratified two-stage cluster sample design, selecting schools within countries and then one or more classes within schools. The stratification variables within a given country reflect

national priorities in sample coverage (e.g. sampling across all regions, or different types of school, see Martin et al., 2016). As a result some population groups may be over- or under-represented in the sample. Additionally in some instances, classes are taught by more than one teacher. Sampling weights provided by the IEA (Foy, 2017a) are therefore used at each level of analysis to avoid unbiased estimates that might arise as a result of the sampling design (Stapleton, 2002). To reflect the fact that students are nested within schools, the data in multi-level SEM must be specified as clustered. The Mplus language allows for addressing all of these issues (Muthén & Muthén, 1998-2017).

Several estimation methods may be used in the SEM framework but the preferred method within this thesis is the Robust Maximum Likelihood (MLR) estimator. MLR allows of the estimation of models with missing data, corrects parameter estimates in cases of non-normality in models built on large samples and enables the integration of categorical data into the model (Brown, 2015), making it appropriate for analysis of TIMSS data.

Sample size is critical in applying SEM. Sample sizes of below 100 are considered a potential threat to meaningfully interpretable results (Anderson & Gerbing, 1984; Brown, 2015). Analysis of PISA and TIMSS data, which includes many thousands of students, is at the student level thus well within the standards for acceptable sample size. At the classroom and teacher level however there is room for caution. In multiple-group modelling, 100 cases per group is the rule of thumb (Kline, 2005), a condition which is met in Study II, but which the grouped approach in Study III falls just short of. In instances of small sample sizes in SEM, attention towards model fit is of especial importance.

In assessing the model fit of models in the SEM framework (including CFA and MI), there are multiple statistics that can be used. Absolute fit indices indicating the how well the model fits the sample data, which are commonly examined in CFA are the χ^2 goodness-of-fit test, the Root Mean Square Error of Approximation (RMSEA), and the Standardised Root Mean Square Residual (SRMR). Available incremental fit indices for assessing model fit are the Tucker-Lewis index (TLI), and the Comparative fit index (CFI). To sufficiently assess model fit a combination of fit statistics should be consulted. Combinations of fit indices that can be used include TLI and SRMR, RMSEA and SRMR, and CFI and SRMR (Hu & Bentler, 1999). RMSEA is considered to be particularly informative for researchers as it is sensitive the number of parameters in the model (Diamantopoulos & Siguaw, 2000), favouring those with fewer

parameters and providing a confidence interval around the estimate. As such the RMSEA allows researchers to more precisely test the null hypothesis. RMSEA values of .07, (with an upper limit of less than .08) are held to indicate good fit (Hooper, Coughlan, & Mullen, 2008). Perfect fit is indicated in the SRMR by a value of 0, with a value less than .05 deemed well fitting (Hooper et al., 2008). For both the TLI and CFI, a value greater than .95 indicates good fit (Hooper et al., 2008). Goodness of fit indices favour simpler models (Hox & Bechger, 2007), with a fully saturated model fitting the data perfectly. However as such a saturated model is almost as complex as the underlying observed data its utility in understanding the investigated phenomena is limited, and researchers must balance the complexity of the model with the simplicity that will answer the research questions (Hox & Bechger, 2007).

Validity

Validity is the process by which we judge whether the design and measurement of a study investigates the phenomena we explore accurately, and thus whether inferences drawn from the study are true (Shadish, Cook, & Campbell, 2001). The evaluation of the validity of the studies in this thesis takes two parts. Firstly the four forms of validity – internal, statistical conclusion, construct, and external – are discussed as closely linked pairs. Secondly the validity of the thesis as a whole is considered through a neo-Messickian framework (Newton & Shaw, 2014) to position it within the field.

Internal validity and statistical conclusion validity

Across the social sciences (including educational science), internal validity denotes inferences as to whether covariation between two or more variables reflects a causal relationship (Shadish et al., 2001). While the cross-sectional nature of ILSAs might initially preclude the establishment of a causal relationship between variables considering the specific constructs included in this thesis this concern can be rejected. Considering the time order of the independent variables and the dependent variable across the constituent studies (De Vaus, 2001), there is a clear directionality from the independent to the dependant variables. For example SES in an independent variable in Study II and Study III. As SES is established though family habitus (e.g. Bourdieu, 1984), it cannot logically be influenced by experiences in the school setting or achievement scores while the inverse is logically possible. However, despite the

logical directionality of the relationships between variables, indirect effects are important to consider when modelling relationships, as is illustrated in Study II.

Statistical conclusion validity is closely related to internal validity and focuses on errors in assessing covariation (Shadish et al., 2001). In this thesis issues of statistical conclusion validity are addressed by using large number of participants to ensure statistical power, particularly in Study I and Study II. The division of the Swedish sample from TIMSS 2015 by teacher specialisation represents a threat to statistical conclusion validity. In Study III the group sizes at the teacher level fall just below the recommended size of 100 cases (Kline, 2005). To accept the results of the constituent studies the stringent application of tests of significance is required (as laid out in, for example, Hu & Bentler, 1999).

Construct validity and external validity

Construct validity requires both an understanding of the concepts within a study and an assessment of them (Shadish et al., 2001). The two central concepts explored in this thesis are SES and OTL. Across the constituent studies three different measures of SES and two measures of OTL are applied. The motivation to use multiple measures of the constructs is twofold. Firstly it is rooted in pragmatism as data is drawn from both the OECD's PISA and the IEA's TIMSS studies. Secondly it is influenced by the goals of the individual studies, with the studies variously exploring the measurement of a single concept (SES) at different time points (Study I), international themes of inequality (Study II), and differing patterns of inequality between two groups at a single time point in Sweden (Study III). However, the choice to use multiple measurement approaches presents a threat to construct validity in the thesis.

A counterweight to this threat is the use of CFA in measurement model construction in Study I and Study III. Building on a strong theoretical model (Brown, 2015), CFA allows the researcher to evaluate whether the theoretical model fits the data. While this accurate representation is important in the building of all latent variables it is specifically important within this thesis. Study I applies the same model to data collected from multiple cycles, and Study III models latent phenomena in two sub-populations. As such it is imperative to establish that the latent structures do correctly apply to these multiple populations. The well-fitting CFAs in this analysis are validated through MI testing (Study I and III) and alignment analysis (Study I).

The loci of external validity lies in the transfer of findings to a wider population that was not included in a particular study (e.g. Cronbach et al., 1980). The stratified random sample designs (discussed in an earlier section in this chapter) deployed by the OECD and IEA are the mechanism that enables a judgement as to the external validity of this thesis, as the random element of the sample guarantees that the average observed relations can reasonably be expected to be observed in the wider population (Shadish et al., 2001). Specific analytical techniques, such as the use of a Monte Carlo simulation to confirm the trustworthiness of the measurement model in Study I are particularly pertinent for evaluating the external validity within the thesis.

Positioning the thesis

Having considered the four commonly discussed aspects of validity in quantitative research, it is germane to evaluate this thesis as a whole. Newton & Shaw's neo-Messickian framework for the evaluation of testing policy combines technical and social evaluations of educational assessment in an easy to follow matrix (see, e.g. Newton & Shaw, 2014, p. 186). The framework is an evolution of Messick's (1980) progressive validity matrix, which bound scientific and ethical approaches to validity with evaluations of construct validity (Newton & Shaw, 2014). Providing three foci for evaluating testing policy across two levels (the technical and the social), the neo-Messickian framework is a more accessible tool for evaluation than its predecessor which requires adherence to a strict and somewhat difficult to understand logic (e.g. Hubley & Zumbo, 2011). While explicitly geared towards assessing testing regimes, Newton and Shaw's framework can in this instance be used to discuss the validity of this thesis and its consistent studies within the broader ILSA ecosystem.

Newton and Shaw provide questions within each cell of their neo-Messikian framework through which it is possible to analyse the validity of this thesis. The technical evaluation aspects of the neo-Messickian framework are perhaps the most straightforward to interpret. Firstly, *'Is it possible to measure the desired attribute using the test?'* (all italicised questions per Newton & Shaw, 2014, p. 186). This cell encompasses construct validity. Through the use of a rigorous measurement model establishing process and reliability testing, the internal and external structures of the concepts, and their differences over time and between groups, are comprehensively examined in the thesis. Secondly, *'Is it possible to*

make more accurate decisions by incorporating test scores into the decision-making progress?' The different measures of SES and OTL deployed in Study II and Study III are used to investigate the phenomena in differing contexts (in different national and temporal contexts) and allow for reflection on the implications of different measurement approaches. Thirdly, *'Is it possible to achieve a range of secondary impacts by implementing the testing policy?'* This cell assesses the impact argument for conducting the project. Study III in this thesis delivers a greater understanding of how teaching is distributed between social groups, and how balanced teacher use of time for various topics is used and as such objectively meets this standard.

The social implications of secondary analysis of ILSA data should be strongly considered by any researcher aiming to disseminate their work beyond the dustiest corners of academia. Turning to the social evaluation cells of the framework, the questions become harder to answer. In terms of the research's measurement objective, *'Have all of the primary measurement expenses been considered?'*, arguably the social burden of this research is neutral. By creatively using existing data no burden is placed on the participants. The next cell, evaluating *'Have all of the primary decision-making expenses, pay-offs, impacts and side-effects been considered?'* is explored in the integrated discussion in Chapter 6. Finally when considering secondary policy objectives, *'Have all of the secondary and incidental expenses, pay-offs, impacts and side-effects been considered?'*, the project leaves scope for meeting this requirement. Popular science communiqués and further dissemination of the findings are an avenue that remain open beyond the defence of this thesis.

By considering the questions posed by Newton and Shaw's framework it is possible to form an overall judgement as to whether it is acceptable, both technically and socially, to implement this thesis project. The technical aspect of this project is sufficiently high quality according to Newton and Shaw's (2014) evaluation structure, and the aims and outcomes of the work fall within a band of reasonably accepted data use that participants have consented to.

Reliability

As a secondary data analysis, this thesis relies to a substantial extent on the sampling methodologies of the IEA and OECD studies in order for the findings to be generalizable. In addition to trusting that the sampling procedure was implemented as described in technical reports (see Adams & Wu, 2002; Martin & Mullis, 2012; Martin, Mullis, & Chrostowski, 2004; Martin et al., 2016;

OECD, 2005, 2009, 2012b, 2014, 2017; Olson, Martin, & Mullis, 2008), it is necessary to trust that substantial measurement error was not induced by the conditions in which the data was gathered. With sample sizes in the several thousand per country and cycle, and respondents spread over wide geographic areas any study using this type of data cannot account for external influences on performance during the administration of the tests (i.e. activated fire alarms or heatwaves). The reliability of the dependent variables in Study II and Study III, that is mathematics and science achievement, can be easily confirmed through the IEA's technical reporting documentation. These achievement scales are viewed as having good reliability with international median reliability coefficients above .80 (see Martin & Mullis, 2012; Martin et al., 2016; Olson et al., 2008).

In analyses utilising latent variables it is paramount to ensure the items used to indicate the latent construct are internally consistent and measure the construct in the same manner (Bryman & Cramer, 2011), as unreliable measures can erode the power of further modelling using the construct (Bonett & Wright, 2015). International assessments typically conduct and publish reliability testing for the items and scales derived from multiple indicators in their background questionnaires. However the data choices within the constituent studies do not use pre-calculated scales (as an example, TIMSS does not provide an OTL scale item), and as such the technical documentation does not provide reliability confidents for the constructs (in contrast with, for example, the Student Bullying Scale or the Safe and Orderly School – Teacher's Report Scale. See, Martin et al., 2016). Consequently the reliability of the constructs used in these studies needed to be assessed individually.

To assess the reliability of the independent variables Cronbach's Alpha was calculated for the items indicating the latent constructs in Study I and III, and the variable parcels in Study II and Study III (as tabulated in Appendix C). While the Cronbach's Alpha for the latent constructs generally indicated acceptable internal consistency (Taber, 2018), in the notable case of OTL in Study III this was not the case (α=.520). Examining the Alpha of the questionnaire items which make up the variable parcels for the four domains of mathematics (Table C4) further indicated a reliability problem with the items used to indicate content coverage. The low Alpha values for both the latent OTL variable and the variable parcels which were used to indicate this latent factor in Study III are a concern in assessing the reliability of the findings of this thesis. A possible explanation for the non-optimal Alpha values of the variable parcels and the

latent factor may be heterogeneity of the items within the parcels (Streiner, 2003). The breadth of the mathematics curriculum which is assessed by TIMSS is distilled into the four domains of number, algebra, geometry, and data and chance, which are not equally represented in the number of topics included in the content coverage questionnaire.

Interestingly the variable parcel including all four domains in mathematics used in Study II has a larger Alpha value for Sweden in 2015 than the latent construct used in Study III. A possible implication of this inconstancy that will be discussed in a later section of this thesis is that the modelling of the OTL construct may have bearing on its reliability. Fundamentally however, as a secondary analysis, this thesis is limited by the design choices made by the OECD and the IEA (Shadish et al., 2001). While the reliability of some of the constructs might arguably undermine them, the findings of this thesis should be read as bounded by their origins.

Research ethics

All the data used in this thesis is publicly available and provided fully anonymised. PISA data and documentation were downloaded from the OECD's website[2], and TIMSS data and documentation were accessed via the IEA's online data repository[3]. Due to the public and anonymised nature of the data, authorisation for this project was not sought from the University of Gothenburg's Ethics Committee.

[2] https://www.oecd.org/pisa/data/
[3] https://www.iea.nl/data-tools/repository

Chapter 6 Empirical Studies and Discussion

This thesis is formed of three empirical studies. This chapter provides an overview of each of these studies and an integrated discussion of their results. Three research questions were introduced in Chapter 1, (i) *How might socioeconomic status be consistently measured over time?* (ii) *How do unequal opportunities relate to unequal outcomes?* And (iii) *How can inequality be contextualised in Swedish schools?* These questions are first addressed in the summaries of their corresponding papers and secondly considered in the integrated discussion. Finally the chapter accentuates the contribution of this dissertation to the field of knowledge and suggests avenues for further research.

Study I: Tailoring a measurement model of socioeconomic status: Applying the alignment optimization method to 15 years of PISA.

Socioeconomic status is the key contextual construct measured in international large scale assessments and is commonly seen as a powerful indicator of educational achievement. Within the PISA study SES is operationalised as ESCS, a multi-component instrument which is estimated at a cross-national level. ESCS suffers from validity concerns in its data collection instrument and previous research has shown some of the components to be ill-fitting in many national contexts. The aim of this study was to investigate the properties of recurrent items used to calculate ESCS in PISA and build a bespoke model of SES for Sweden that is statistically valid across multiple PISA cycles.

The study used Swedish contextual data relating to 26,043 students from 6 cycles of PISA (between 2000 and 2015). The recurrent items were examined for stability over time, before a measurement model was created to fit the 2000 cycle data using confirmatory factor analysis. The measurement model was assessed over the additional 5 cycles using measurement invariance testing and alignment analysis.

The findings of this study demonstrate that the continual inclusion of repeatedly used SES items in the student questionnaire was warranted. A measurement model was created for the 2000 cycle of PISA which could be replicated and was well-fitting across the subsequent cycles of Swedish PISA data. The final model possessed metric invariance indicating that the factor loadings in the model were similar across time. By using the alignment optimisation method in a within-country cross-time analysis the model's lack of scalar invariance was addressed and the model was deemed trustworthy across time-points.

Study II: Does inequality in opportunity intensify inequality in outcomes? International evidence from four TIMSS cycles.

Student socioeconomic background and the amount of subject content (or Opportunity to Learn – OTL) they are exposed to are held to significantly influence student outcomes. Socioeconomic inequality of outcomes has been perennially observed in educational assessment and a topic of investigation since the mid-twentieth century while a body of literature suggests that there is an equality gap in OTL with more advantaged students offered more content converge through their mathematics lessons. The aim of Study II was to ascertain the presence of socioeconomic inequalities in opportunity and outcomes in mathematics and science and to investigate whether unequal opportunities mediate socioeconomic inequalities in outcomes. Data from the 2003, 2007, 2011, and 2015 cycles of TIMSS was used in this study. In total data from 78 countries was used representing 965,029 8th grade students in 40,051 mathematics classrooms, and 936,964 8th grade students in 39,156 science classrooms.

The results of this study revealed that opportunity gaps in mathematics were typically small and do not differ statistically from zero. Inequality of outcomes in mathematics was observed almost universally. While some countries (i.e. Egypt and Chinese Taipei) saw their achievement gaps close over the 4 cycles of TIMSS, the relationship between a class's socioeconomic background and achievement was strong and increased from 2003 to 2015. There was scant evidence of schooling mediating the effects of SES on achievement. Small and significant indirect effects were observed in a select group of uniformly wealthy countries including England, Malta, Scotland, and Singapore.

While Sweden exhibited an achievement gap between more and less advantaged classes of students at each of the four time points in the study, inequality of opportunities was only present in 2003 and 2015. Moreover schooling mediated the effects of SES on achievement in only the 2003 cycle for Sweden. These results suggest that Sweden offers equitable mathematics provision in line with its comprehensive school model.

Study III: Integrating educational quality and educational equity into a model of mathematics performance.

As the educational experiences manifested at classroom level form the core of opportunity to learn, the key actors in implementing the curriculum – teachers – are essential for understanding how OTL functions. Study III integrated teacher characteristics into a model of educational equity for Swedish eighth-grade mathematics students. The study examined 3888 students and 190 teachers who participated in TIMSS 2015 and explored multiple equity gaps including teacher quality, opportunity and achievement.

When considered within a single group model the results showed that there was a moderate teacher quality gap, accompanied by substantial gaps in achievement and opportunities between classes of differing levels of socioeconomic status. The cohort was subsequently divided by whether the teacher was a mathematics specialist, with 2114 students taught by 99 specialists, and 1774 students taught by 91 non-specialists. Differing patterns of inequalities emerged in the two group model. For the classes of specialist teachers there was a moderate opportunity gap and a strong correlation between the class's SES and the teacher's perception of the school ethos towards academics. Classes with non-specialist teachers displayed a moderate teacher quality gap and a moderate relationship between the class SES and the teacher's perception of the school ethos towards academics. The findings of this study underscore the importance of having high-quality teachers in mathematics classrooms as a possible mitigator of inequality in outcomes.

Integrated Discussion

The three studies that comprise this thesis explored educational inequality in terms of opportunities and outcomes at international and Swedish levels. Three principal themes emerged across the constituent studies:

1. The implications of different approaches to measuring inequality (Study I, Study II, and Study III).
2. Persistent inequalities in outcomes (Study II and Study III).
3. Contextualising the opportunity gap (Study II and Study III).

The implications of different approaches to measuring inequality

Establishing the presence or absence of equality within educational systems requires the measurement of intangible concepts such as student background, opportunity, and achievement. The measurement of achievement is provided in this thesis through the multiple plausible values for achievement provided in the TIMSS dataset, which in itself has implications for the accuracy of the achievement measure (Martin et al., 2016). When exploring the performance of the SES and OTL measures deployed across the constituent studies some interesting differences emerge.

In examining the achievement gap in TIMSS 2015 (i.e. the relationship between SES and achievement) in Sweden, it becomes clear that the SES measure chosen has implications on the effect size of the relationship. In Study II a one standard deviation rise in SES resulted in a .237 standard deviation increase in performance when the SES measure was books (Rolfe et al., under revision, Appendix G), and a .375 standard deviation increase in performance when parental education was used (Rolfe et al., under revision, Appendix I). The stronger predictive power of parental education on achievement in this instance reflects Tan's (2017) finding of parental education being the strongest cultural capital indicator of student achievement. Meanwhile, when SES was operationalised as a latent factor in Study III, an increase in SES resulted in a .605 increase in achievement (Rolfe et al., under revision, Table 4). The ambition of Study II to examine 78 countries across four TIMSS cycles made the choice of single indicators of SES and a parcelled OTL construct a pragmatic one. In the principal analysis in this study (with books as the SES measure and mathematics achievement), there were 198 individual models. Applying latent variable modelling to this vast modelling effort would have

yielded an almost uninterpretable output. There are further limitations to the choice of SES measure in Study II as TIMSS retains very few home possession items over time, with 'a desk' being the only possession other than the number of books appearing consistently worded in the 2003-2015 cycles. The contrast in these two approaches to operationalising SES – as a single item measure and as study-specific measure – while common in contemporary secondary analysis of ILSA data (e.g. Strietholt et al., 2019), both reaffirms that composite measures of SES correlate strongest with achievement (e.g. Lee et al., 2019) and challenges prior thinking about the measurement of SES.

The discrepancy in the size of the relationships between SES and achievement for Sweden across Studies II and III calls into question some of the theoretical underpinnings of the operationalisation of SES. While single item measures are assumed to overestimate SES effects (Sirin, 2005), in these studies they appear to underplay the effect of SES on achievement. Single item measures do not sufficiently capture Bourdieu's (1986) three forms of capital but rather books in the home indicates objectified cultural capital and parental education represents institutionalised cultural capital. The latent model in Study III on the other hand encompasses a broader picture of a family's capital by reflecting both these aspects of capital.

The absence of a consistent SES index in the TIMSS dataset drives the divergent approaches to measuring SES in Study II and Study III. Conversely the PISA dataset does include a recurrent SES index, ESCS. Study I offers a further approach to measuring the essential concept in inequality. The tailored measurement model for SES in Sweden addresses some of the concerns (e.g. Rutkowski & Rutkowski, 2010; Rutkowski & Rutkowski, 2013; Schulz, 2005) in the literature over the properties of PISA's ESCS. A measure that is trustworthy in the Swedish context is perhaps better used in investigating equality issues across time in PISA data than the existing ESCS measure.

The predictive power of OTL on achievement is fundamental to the concept (e.g. Eggen et al., 1987) and has been well documented in the literature (e.g. Luyten, 2017; Scheerens et al., 2007), but the contradictory findings of Study II and Study III call this assumption into question. Comparing the effect of OTL on achievement in TIMSS 2015, OTL was a small but significant predictor of achievement in Sweden in Study II but was non-significant for the whole cohort model in Study III. The different OTL measures used in these two studies both drew on 20 items from the teacher questionnaire (see Table A.1). However in Study II OTL was manifest (the standardized mean of these 20 items), and in

Study III it was latent (indicated by four variable parcels representing the sub-domains of mathematics). The manifest OTL variable had a higher reliability than the latent one which is counter to the theoretical understanding of latent variable modelling's ability to reflect the reality of uneven focus on the sub-domains with mathematics teaching.

The findings of the three constituent studies together underscore the importance of the careful consideration of item choice and construct measurement in analyses of inequality using ILSA data. Where exploring phenomena at multiple time points creates a play-off between latent variable modelling and manifest variables the researcher's solution can be elucidated on a potential limitation to the magnitude of inter-variable relationships.

Persistent inequality in outcomes

As one of the key concerns in contemporary pedagogy and politics (Jerrim et al., 2019), inequality in outcomes is an essential component in any examination of the organisation of schooling and access to quality education. To this end, inequality of outcomes, expressed as the achievement gap, was a fundamental to examining the implementation of curriculum in this thesis.

Study II examined inequality of outcomes in four cycles of TIMSS and 80 countries. Inequality of outcomes was almost universal. Classes with higher SES outperformed those with lower SES and the global average achievement gap was consistent across time. Achievement gaps in Sweden were just below the global average but were rather consistent, with a small narrowing of the achievement gap from the 2003 to the 2007 cycles being mirrored by an increase in the gap between 2001 and 2015. These results reiterate findings of earlier contributions which suggested persistent achievement gaps across various international studies (e.g. Broer et al., 2019; Chmielewski, 2019; Reardon, 2011). The focus in Study III was narrowed from an international perspective to Sweden alone. Again a significant achievement gap was observed reflecting evidence from both ILSAs and national data (e.g. Chmielewski, 2019; Löfstedt, 2019). However this achievement gap was only present in classes with non-specialist teachers when the cohort was split by teacher specialisation.

The findings from Study II and Study III are indicative of an underlying segregation in wider society. Earlier studies have established the link between school segregation and achievement gaps (explored in the European context by, for example, Biedinger, Becker, & Rohling, 2008; Boado, 2007; Brookover

et al., 1978; Fekjær & Birkelund, 2007; Van der Slik, Driessen, & De Bot, 2006), which are manifested in the school system through student recruitment processes (e.g. Andersson et al., 2010; Böhlmark et al., 2016; Yang Hansen & Gustafsson, 2016). Despite widespread concern about the existence of achievement gaps, the findings of this dissertation reiterate the systemic ubiquity of inequality of outcomes.

Contextualising the opportunity gap

The final theme evident in this dissertation is the need to contextualise the opportunity gap. The classroom is the seat of the implemented curriculum and is the arena in which students encounter a selection of experiences which are considered needful for their progression to adult life. Study II examined opportunity gaps across multiple systems and time points. In the majority of instances opportunity gaps were non-significant. Instances in which classrooms with more socioeconomically advantaged students received more teacher reported content coverage were generally dominated by highly developed nations, particularly those in the Anglosphere, perhaps reflecting a preponderance of US based research in the field (e.g. Lamain, Scheerens, & Noort, 2017).

In the Swedish context, Study II revealed an inconsistency of evidenced opportunity gaps, which occurred in only the 2003 and 2015 TIMSS cycles. The opportunity gap in 2015 was corroborated by the findings of Study III. When OTL was operationalised as a latent variable in Study III, there was a significant opportunity gap of .448 in the single group model. When the model was grouped by specialist and non-specialist teachers there was only a significant opportunity gap in classes with specialist teachers.

As the actors charged with enacting (Porter & Smithson, 2001) the curriculum and determining the selection and sequencing of experiences students are exposed to (Schmidt et al., 1997), teachers have a substantial role to play in examining opportunity gaps. The overall opportunity gap in Sweden exists within a system where there is unequal access to qualified teachers (Akiba et al., 2007). That the opportunity gap persists in classes with specialist teachers, but not in those with non-specialist ones underscores the importance of teachers in implementing the curriculum. Swedish teachers have great latitude for determining the sequence of curriculum experiences over a three year period (The National Agency for Education, 2018a), and unobserved teaching

practices among specialist teachers appear to offer context for opportunity gaps.

Contribution

This thesis contributes to the field of educational equality in multiple ways. The empirical results of the constituent studies within this thesis highlight the importance of investigating the measurement of equality-defining constructs. Secondary analysis of international data often goes beyond the initial aims of the study design and researchers are left exploring phenomena in ways that were not intended (for example across time) using items which offer limited response options. The empirical results of this thesis offer an exploration of multiple approaches to operationalising SES and OTL. While these approaches are individually bounded by the data and aims of the constituent studies, collectively they contribute to the understanding of the possibilities and limitations of ILSA data for examining equality in education.

Empirical evidence in this thesis highlights the global and persistent socioeconomic inequality in student outcomes. Despite the variation in the size of the achievement gap at different time points their pervasiveness should be a concern for all stakeholders in the educational process. This thesis does not offer evidence, however, that these gaps are exacerbated by OTL in the majority of national settings. While there is space for further exploration of the links between SES, OTL, and achievement, this thesis offers caution in interpreting OTL as a mediator of the achievement gap.

Finally this thesis provides contextualisation of the opportunity gap, particularly in the Swedish context. Empirical evidence in this dissertation indicates that inequality in opportunities is not as universal as previously supposed. These inequalities are concentrated in highly developed nations, with the notably strong opportunity gaps in English-speaking countries suggesting a distinct cultural norm within the Anglosphere. In instances where there is a significant opportunity gap the findings within this thesis suggest that integrating teacher characteristics can explain or ameliorate these inequalities.

Further Research

In considering areas for further inquiry following this dissertation, several possibilities appear. A natural progression of the research is to integrate the contribution to measurement made by Study I with the breadth of country

coverage in Study II to establish trends in OTL. While the reliability of the OTL construct in Study II calculated on a per cycle basis as the sum of the items had generally good reliability there was a great deal of variation in the reliability of the construct between countries within cycles and also between cycles per country. The high reliability for some countries (i.e. England) might suggest that there is a bias in the way that the curriculum is interpreted and synthetized in TIMSS. As such a necessary area for future research might be to examine correspondence between OTL items, test items and curricula in order to more fully explore the properties of various approaches to operationalising OTL. The measurement of OTL as a latent construct could be further explored in a trend analysis (by, for example, only using OTL items repeated in all cycles), with the between country and across time trustworthiness of the construct an area of particular interest.

An avenue for deepening knowledge of the teacher influence on curriculum implementation and student outcomes in the context of international assessments could be to further model the determinants of teacher quality. Integrating concepts from the realm of educational effectiveness such as teacher self-efficacy and motivations may help to further unpack the processes behind curriculum implementation. Specific to the Swedish context is the possibly of integrating national register data to selected cycles of TIMSS with the aim of parsing out how developments in teacher education may impact educational opportunities in Swedish classrooms.

Swedish Summary

Under många årtionden har ett viktigt inslag i det svenska skolsystemet varit att tillhandahålla lika utbildningsmöjligheter i en integrerad miljö (Arnesen & Lundahl, 2006). Denna utbildningsmodell, ofta refererad till som ”en skola för alla”, delades med Sveriges nordiska grannar och ansågs vara central för den socialdemokratiska välfärdsstaten. Under 2000-talet utvecklades dock ett socio-ekonomiskt prestationsgap i Sverige och allt fler elever lämnar grundskolan utan fullständiga betyg. Forskning visar att skolsegregation med avseende på elev-sammansättning, prestation och möjligheter till lärande har ökat (t.ex. Mullis, Martin, Foy, et al., 2016; 2017; OECD, 2016; Skolverket, 2005; 2020a) och så har även betydelsen av familjebakgrund för elevers prestationer (Löfstedt, 2019).

Likvärdig utbildning är en av de viktigaste pedagogiska och politiska frågorna i vår tid (t.ex. Baker et al., 2002; Broer et al., 2019; Jerrim et al., 2019; Keeves, 1992). Främjande av likvärdighet genom utbildning har varit ett fram-stående tema inom utbildning över hela världen sedan en lång tid tillbaka (Coleman et al., 1990; United Nations General Assembly resolution 70/1, 2015). Denna avhandling fokuserar på skolans likvärdighet i termer av socio-ekonomiska skillnader i elevers skolprestationer och möjligheter att lära.

Bakgrund

Sedan början av 1990-talet har det svenska skolsystemet genomgått flera betydande förändringar. Det har reformerats i enlighet med marknads-ekonomiska logiker, kontrollen av utbildningen har decentraliserats, fria skolval har införts. Sedan friskolereformen och fria skolvalet har antalet friskolor ökat markant och 15% av eleverna i grundskolan går nu på en friskola (Skolverket, 2018b, 2020b). Det finns ett brett utbud av skolor att välja mellan, med olika pedagogiska inriktningar (Lundahl, 2016).

Under denna reformperiod förändrades också det svenska samhället. Det svenska välfärdssystemet försämrades och såväl inkomstskillnaderna (Aaberge et al., 2018) som bostadssegregationen ökade (Bevelander, 2004; Malmberg et

al., 2016). Andelen utlandsfödda medborgare ökade också markant (Migrationsverket, 2018) och antalet elever som fick modersmålsundervisning fördubblades (Skolverket, 2018c, 2018d).

Tidigare forskning indikerar en ökande segregations avseende socioekonomisk och utländsk bakgrund mellan skolor (t.ex. Söderström & Uusitalo, 2005; Yang Hansen & Gustafsson, 2016) sedan introduktionen av det fria skolvalet. Boendesegregation förklarar större delen av mellanskolsvariationen (Holmlund et al., 2014; Malmberg et al., 2016), och denna variation återspeglas i ökade prestationsgap på skolnivå (Skolverket, 2020a). Skolor i mindre priviligierade områden har svårt att locka till sig och behålla lärare (Borelius, 2010; Möller, 2010), vilket påverkar utbildningens likvärdighet och elevers möjligheter till lärande.

Sveriges resultat i internationella storskaliga studier återhämtar sig för närvarande efter en lång period av nedgång (Mullis, Martin, Foy, et al., 2016; 2017; OECD, 2016). I jämförelse med övriga OECD-länder har nedgången i Sveriges skolprestationer har varit bland de kraftigaste (Löfstedt, 2019). Trots att Sveriges resultat i de senaste internationella kunskapsmätningarna har förbättrats, har dock prestationsskillnaderna mellan skolor ökat (t.ex. Chmielewski, 2019). Sveriges oregelbundna resultat i internationella kunskapsmätningar och stora mellanskolsvariation gör det intressant för att studera ojämlikhet i ett internationellt sammanhang.

Socioekonomisk status (SES) och möjlighet att lära (OTL) är nyckelbegreppen i denna avhandling. Socioekonomisk status kan beskrivas som att rangordna en individ eller en familj i en hierarki efter deras innehav eller kontroll av resurser så som rikedom, makt eller social status (Mueller & Parcel, 1981). SES har en lång och väldokumenterad förklaringskraft inom utbildningsvetenskapen (t.ex. Coleman et al., 1966). Enligt Bourdieu (1986), kan SES ta sig i uttryck genom tre sammanflätade aspekter: socialt kapital, kulturellt kapital och ekonomiskt kapital. Socialt kapital gäller familjens sociala förbindelser och nätverk, kulturellt kapital inkluderar kulturell och pedagogisk konsumtion och ekonomiskt kapital avser ekonomisk status. De högre sociala klasserna har länge haft de starkaste utbildningsresultaten. Utifrån Bourdieus teoretiska ansats förklaras detta med att utbildningssystemet reproducerar de fördelarna av en högre social klass, att socioekonomiskt starka föräldrar sätter större värde på utbildning samtidigt som de har de resurser som krävs för att säkerställa sina barns framgång (Goldthorpe, 1996). Betydelsen av kulturella representationer som används för att indikera socioekonomisk status förändras dock över tid

(Goldthorpe, 1996), och det är därför viktigt att överväga hur socioekonomisk status operationaliseras innan man använder begreppet i studier av skolans likvärdighet.

Under lång tid har mätningen av SES byggts på en sammansättning av föräldrarnas, utbildning, yrke och inkomst (Duncan et al., 1972; Gottfried, 1985; Hauser, 1994; Mueller & Parcel, 1981; White 1982). I många internationella storskaliga studier är det vanligt att ersätta föräldrainkomster med ett mått på resurser i hemmet (Cowan et al., 2012; Sirin, 2005) och att inkludera ytterligare variabler. SES visar också en signifikant påverkan på elevprestationer (Lee et al., 2019). Det är dock inte ovanligt att forskare använder enskilda variabler för att mäta SES (Strietholt et al., 2019). Det finns oenighet i litteraturen om vilken enskild SES-indikator som bäst kan förutsäga skolprestationer; vissa argumenterar för föräldrarnas utbildning (Tan, 2017), och andra för föremål i hemmet (Sirin, 2005).

Begreppet ”Möjlighet att lära” (OTL) bygger på idén om att exponering för ämnesinnehållet kommer att ha ett starkt inflytande på prestationer (Eggen et al., 1987), och att undervisningsinnehållet är förknippat med undervisningskvalitén och lärandemiljön (McDonnell, 1995). Många studier har visat att OTL har ett positivt samband med elevers matematikprestationer (t.ex. Dupriez & Dumay, 2006; Fuchs & Woessmann, 2007; Gamoran et al., 1997; Reeves, 2012; Rowan et al., 2002; Schmidt et al., 2001; Schmidt et al., 2001). Då OTL skapas genom lärares praktik och tolkning av läroplanen (t.ex. Porter & Smithson, 2001; Schmidt et al., 1997), kan förutsättningarna för elevers OTL variera mellan klassrum och skolor. Detta innebär en risk för skolans likvärdighet.

De stora förändringarna i det svenska utbildningssystemet sedan 1990-talet kan förstås som möjliga påverkansfaktorer i relation till Sveriges fluktuerande resultat i olika internationella storskaliga studier, samt till det växande prestationsgapet. I detta sammanhang kan socioekonomisk status och möjligheter att lära användas i analysen för att fördjupa förståelsen av förändringen i likvärdighet i svenska grundskolan.

Syfte

Avhandlingens syfte är att undersöka likvärdighet i svenska grundskolan utifrån ett internationellt perspektiv. Avhandlingen fokuserar på skillnaderna i elevernas prestation, socioekonomisk bakgrund och möjlighet att lära, och

undersöker mekanismerna bakom dem. I avhandlingens tre studier undersöks likvärdighet från olika perspektiv:

Studie I undersöker hur begreppet socioekonomisk status kan operationaliserats över tid i Sverige.

Studie II utforskar samspelet mellan socioekonomisk status, möjligheten att lära och prestationer – vid flera tidpunkter och länder.

Studie III fokuserar på hur lärarnas utbildning (i.e., specialiserade och icke-specialiserade lärare) påverkar relationen mellan SES, OTL och prestation.

De tre studierna visar genomgående på förekomsten av prestationsskillnader i Sverige, likväl som dess förbli över tiden. Avhandlingen undersöker relationerna mellan elevers socioekonomiska bakgrunder och de möjligheter som finns inom klassrummen. Denna relationerna är en förklarande faktor i relation till detta prestationsgap både internationellt och inom Sverige. Skillnaderna finns i svenska skolor ger kontext till missanpassningar mellan läroplanen som granskas i internationella bedömningar och läroplanen som undervisas i svenska skolor. Detta utgör grunden för den integrerade diskussionen i denna avhandling.

Teoretiskt Ramverk

Avhandlingens teoretiska ramverk utgår från modellen för potentiella utbildningserfarenheter och Bourdieus teori om social reproduktion. I en första del kopplar det teoretiska ramverket ihop de två huvudsakliga begreppen i avhandlingen (socioekonomisk status och möjligheter att lära) via modellen för potentiella utbildningserfarenheter. I en andra del betraktas modellen genom en teoretisk lins formad av Bourdieus teorier om social reproduktion.

Läroplanen har länge ansetts vara erfarenhetsmässig (t.ex. Bobbitt, 1918; Dewey, 1902). Som sådan bygger läroplanen på en rad aktiviteter eller upplevelser som eleverna måste gå igenom i skolan på vägen till vuxenlivet. Även om eleven som en individ är i centrum för denna beskrivning av läroplanen, är utbildning fortfarande ett grupperat projekt med elever inom klasser och klasser inom skolor. Som ett resultat måste läroplanen återspegla gemensamma mål för erfarenhet för deltagarna i utbildningsprojektet. TIMSS-modellen för potentiella utbildningserfarenheter illustrerar utbildnings-erfarenhet som ett känsligt nätverk av flernivårelationer mellan mål, aktörer och val inom systemet, klassrummen och individerna (Schmidt et al., 1997). På systemnivå är läroplaner *avsedda*. Denna avsedda läroplan är utformad och ofta

politiskt styrd på nationell nivå. Inom klassrummen planeras och genomförs den *genomförda* läroplanen av lärare. Den *uppnådda* läroplanen ligger på elevnivå och är ett resultat av den genomförda läroplanen (Houang & Schmidt, 2008; Schmidt et al., 1997). Genom ett antal mål anger länder vad eleverna ska lära sig, lärare implementerar dessa mål i varierande grad inom sina klasser, och eleverna uppnår lärande i olika utsträckning. Summan av dessa åtgärder kan sedan kvantifieras genom elevprestation i internationella storskaliga studier (t.ex. TIMSS).

Den genomförda läroplanen modererar förhållandet mellan den avsedda och uppnådda läroplanen. Läroplanen som manifesteras på klassnivå är ett uttryck för önskade upplevelser i den avsedda läroplanen. Denna manifesterade läroplan är möjlighet. Alla valen som görs på skol- och klassrumsnivå får konsekvenser för möjligheterna. Det är viktigt att förstå hur utbildningsmöjligheter fördelas för att kontextualisera och förstå den uppnådda läroplanen och elevprestationerna samt prestations-gapet.

Tron på att elever kommer att prestera bättre i ämnen och innehåll som de har fått lära sig än de som inte har gjort det (t.ex. Eggen et al., 1987) har länge uppfattats som en möjlighet att lära (OTL) i IEA-studier (se Schmidt et al., 1997). Genom linsen i TIMSS-modellen för potentiella utbildningserfarenheter kan OTL-åtgärden i TIMSS-undersökningen förstås som summan av de många val som görs på nationell, skola- och klassrumsnivå som bestämmer de möjligheter som eleverna får.

I potentiella utbildningserfarenheter modellen påverkar elevegenskaper både den uppnådda läroplanen och den genomförda läroplanen. Därför är det viktigt att överväga potentiell utbildningserfarenhet i samband med elevernas sociala ursprung. Teorin om social reproduktion används för att förstå elevbakgrundens roll i utbildning. Inom detta ramverk framhålls att utbildning bidrar till reproduktion av maktförhållanden mellan sociala grupper (Bourdieu, 1971). Social reproduktion har skett genom skolan sedan antiken (t.ex. Guillory, 2013; Lloyd, 1990). Denna länk mellan elevbakgrund och prestation eliminerades inte under 1900-talet, trots fokus på omfattande och meritokratisk utbildning (Coleman et al., 1966; Jencks et al., 1972). Den ihållande kopplingen mellan socioekonomisk status och prestation i litteraturen (t.ex. Marzano, 2003; Scheerens & Bosker, 1997; Scheerens et al., 2007) understryker relationen mellan elevbakgrund och erfarenhet inom moderna utbildningsinstitutioner. Enligt Bourdieu (1998) definierar familjen en individs placering i det sociala rummet. Om en enskild person vill avvika från den utbildningsväg som

definieras av familjens position i hierarkin, kommer detta att kräva avsiktliga åtgärder. Dessa potentiella rörelser på individnivå interagerar med de utbildningsmöjligheter som uttrycks på klassnivån i modellen för potentiella utbildningserfarenheter. Som exempel kan familjer flytta sina barn till en bättre skola eller acceptera den skola som de tilldelats. En sådan rörelse kan påverka de möjligheter en elev får och om de upplever social reproduktion inom skolsystemet.

De tre empiriska studierna i denna avhandling granskar läroplanernas förväntningar, leverans, instruktion och resultat från system-, klassrums- och elevnivå. Familjens socioekonomiska status används för att identifiera skillnaden i resultat och variationen i möjlighet att lära i en förmedlad mekanism.

Metod

Sedan millennieskiftet har internationella storskaliga studier blivit det dominerande verktyget för uppföljning och jämförelse av länders skolsystem. Dessa studier ger rika och viktiga data om skolresultat och en mängd kontextuell information för att främja bättre förståelse av hur olika utbildningssystem fungerar samt mekanismerna bakom prestationsgapet (Gustafsson & Rosén, 2014; Nóvoa & Yariv-Mashal, 2003). Denna avhandling baseras på data från två internationella storskaliga studier- PISA (Programme for International Student Achievement) och TIMSS (Trends in International Mathematics and Science Study). Detta avsnitt introducerar dessa två internationella storskaliga studier och de variabler och analysmetoder som används i avhandlingen.

PISA undersöker 15-årigars kunskap inom läsning, matematik och naturvetenskap och utvärderar om eleverna är utrustade med de kunskaper och färdigheter som är nödvändiga för att delta i det fortsatta livet. PISA har genomförts vart tredje år sedan år 2000, och prövar kunskaperna hos 15-åriga elever från medlemsländer i OECD och icke-OECD-länder (så-kallade 'partner-länder'). Över tid, deltar allt flera icke-OECD länder än OECD-medlemmar i de senaste PISA undersökningarna (OECD, 2019). Dessa färdigheter och kunskaper testas genom att be eleverna att tillämpa sitt lärande i nya situationer (OECD, 2019). Varje PISA undersökning har ett huvudområde, vilket roterar vart tredje år (läsning år 2000, 2009 och 2018; matematik 2003 och 2012 och naturvetenskap i 2006 och 2015), dock prövas även de andra två ämnena i varje PISA omgång, dock i mindre utsträckning.

TIMSS-undersökningen har genomförts vart fjärde år sedan 1995 och prövar elevers prestationer i matematik och naturvetenskap för elever i årskurs 4 och 8. TIMSS har ett läroplanbaserat bedömningsramverk, som byggs på gemensam innehållskunskap i alla deltagande länder (Mullis, Martin, Foy, et al., 2016). Syftet med TIMSS-undersökningen är att hjälpa länder att fatta beslut för att förbättra sin undervisning och lärande i matematik och naturvetenskap (Mullis, Martin, Foy, et al., 2016).

Både PISA- och TIMSS-undersökningarna samlar in data med hjälp av rigorösa provprocedurer. PISA-undersökningen använder en tvåstegs-stratifierad urvalsdesign (se t.ex. OECD, 2014). I det första steget väljs skolor som innehar 15-åriga elever. Sannolikheten för att en skola väljs ut står i proportion till antalet 15-åringar som är inskrivna i den. Det andra steget i urvalet väljs elever inom skolan, med en målgruppsstorlek på 42 elever per skola (OECD, 2017). En stratifierad, tvåstegs, klusterprovdesign används i TIMSS-undersökningen. I den första etappen väljs skolor och i den andra etappen väljs en eller flera klasser inom skolan (Martin et al., 2016). I majoriteten av länderna är målsättningen för urvalsstorlek 150 skolor och cirka 4000 elever (Martin et al., 2016). Det rigorösa förfarandet är mycket viktigt för alla vetenskapliga påståenden som görs efter analyser av dessa data. Urvalet i dessa undersökningar gör att slutsatserna från empiriska analyser kan generaliseras till populationen elever av motsvarande ålder.

Valet att använda data från både TIMSS- och PISA-undersökningarna i denna avhandling motiverades av både målen för varje delstudie och av de två internationella storskaliga studiers design. Eftersom målet med Studie I var att bygga en mätmodell för socioekonomisk status, kunde PISA-data användas tack vare denna datamängds expansiva datainsamling om socioekonomisk status. Syftet att undersöka relationerna mellan SES, OTL och prestation vid flera tid-punkter i Studie II krävde användning av TIMSS-data, eftersom PISA-undersökningen har färre mätpunkter för varje huvudområde. Slutligen, för att integrera läraregenskaper i modellen av pedagogisk ojämlikhet i Studie III var TIMSS-data nödvändiga eftersom PISA-undersökningen inte tillhandahåller information från lärare.

Variabler

Studie I använde variabler från 6 cykler av PISA-undersöknings elevfråge-formulären som relaterar till hemresurser och familjebakgrund (ett skrivbord,

ett studieutrymme, läroböcker, utbildningsprogramvara, tillgång till eget rum, en internetanslutning, klassisk litteratur, poesi, konstverk, antal böcker i elevens hem, och föräldrars utbildningsnivå). I den andra och tredje delstudien, användes variabler från TIMSS-undersökningens elev- och lärarfrågeformulär. Båda dessa studier använde elevprestation i TIMSS-undersökningen som resultatvariabel. Studie II användes elevprestation i både matematik och naturvetenskap, men Studie III användes elevprestation i bara matematik. I Studie II, användes antal böcker i elevens hem samt föräldrars utbildningsnivå för att indikera socioekonomisk status. Variabler från lärarfrågeformulären slogs samman för att skapa cykelspecifika OTL-variabler. Eftersom de konstruktioner som undersöks i Studie III (socioekonomisk status, OTL, lärarkvalitet, och lärarens uppfattning om skolans betoning på akademisk framgång) modellerades som latenta variabler, användes flera variabler från elev- och lärarfrågeformulären (se Appendix B).

Analysmetod

En av de mest populära metoderna för statistisk analys inom samhällsvetenskaperna är strukturell ekvationsmodellering (SEM). SEM är ett ramverk inom vilket forskare kan undersöka komplexa förhållanden mellan variabler. SEM har många användningsområden. Forskare kan t.ex. upprätta en mätmodell med så kallad konfirmatorisk faktoranalys för att undersöka relationer mellan ett teoretiskt begrepp genom observerbara indikatorer. SEM-tekniken kan även undersöka komplexa mekanismer mellan olika begrepp genom att koppla samman mätmodeller i en så kallad strukturell modell enligt ett teoretiskt ramverk. Både mätmodeller och strukturella modeller kan undersöka förhållanden mellan variabler på flera nivåer samtidigt (Hoyle, 2012; Hox & Bechger, 2007). Flernivåanalys tillämpas för att ta hänsyn till den hierarkiska datastrukturen. Metoden bryter ned den totala variansen i en utfallsvariabel enligt de observationsnivåer (individ – skola) som finns i data och försöker att förklara variansen på respektive nivå. Flernivåanalys har använts i studie II och III.

Flera av begreppen i denna avhandling är icke direkt observerbara t.ex. socioekonomisk status, möjlighet att lära och lärarkvalitet. Därför används konfirmatorisk faktoranalys (CFA) för att definiera det icke observerbar begreppet (latenta variabeln) med flera observerbara indikatorer. Forskare behöver således en stark teoretisk eller empirisk grund för urvalet av indikatorer

och modellspecifikationen (Brown, 2015). CFA utgör också ett starkt ramverk för att jämföra mätmodeller över grupper och tid (dvs. mellan kohorter vid olika tidpunkter) genom flergrupps-konfirmatorisk faktoranalys (MGCFA). MGCFA integrerar flera grupper i en enda modell och ger underlag för jämförelser mellan grupper (Brown, 2015). Measurement Invariance (MI) metoden ofta tillämpas för att validera mätmodellers jämförbarhet genom att testa om (1) faktorstruktur är identiska (Configural Invariance); (2) faktorladdning för varje indikator är lika (Metric Invariance); (3) förväntade värden (i.e. interceptet) för varje indikator är lika (Scalar Invariance). Denna process är nödvändig för forskare ska kunna göra legitima jämförelser mellan kohorter (Cheung & Rensvold, 2002). För att jämföra medelvärden och variansen av latenta variabla mellan subgrupper krävs Scalar Invariance (Millsap 2012). Detta antagande (dvs. lika faktorladdningar och intercept av indikatorna) misslyckas dock ofta. Dessutom blir chi-^{2} differens-testning för varje parameter mycket besvärligt, särskilt när många subgrupper jämförs. Därför använder denna avhandling en ny utvecklade metod – det så kallade alignment – för att utvärdera invariant av mätmodeller. Alignment metoden möjliggör jämförelse och bedömning av mät-ekvivalens över ett stort antal grupper och subgrupper inom populationer och tillåter partiella invariant i parameter uppskattningarna (Asparouhov & Muthén, 2014; Munck et al., 2017). Alignment metoden bygger på konfigurations-modellen och uppskattar individuellt faktormedelvärde och varians för varje grupp samtidigt som man upptäcker det bäst passande mönstret för mät-invarians (Asparouhov & Muthén, 2014). Denna metod tillämpas i studien I.

Resultat

Studie I

Rolfe, V. (2021). Tailoring a measurement model of socioeconomic status: Applying the alignment optimization method to 15 years of PISA. *International Journal of Educational Research*, 106, doi:10.1016/j.ijer.2020.101723

Socioekonomisk status är en av de viktigaste prediktorerna för utbildnings-prestationer. PISA-undersökningen mäter socioekonomisk status med ESCS-instrument. ESCS har kritiserats i litteraturen på grund av dålig modell-anpassning i flera länder. Studie I använde svenska PISA-data till att utveckla en skräddarsydd modell av socioekonomisk status, vilken kan användas över

flera PISA undersökningar. Resultaten visade att det är möjligt att bygga en mätmodell av socioekonomisk status som utnyttja de frågorna som ingick i alla PISA undersökningar. En mätmodell konstruerades för PISA 2000, och testades sedan över de följande fem PISA undersökningar (PISA 2003, 2006, 2009 och 2015). Mätinvarians testades med den så kallad alignment analysis. Den slutgiltiga modellen visade god modellanpassning över alla PISA undersökningar, och det illustrerade ett nytt tillvägagångssätt för operationalisering av socioekonomisk status i flera tidpunktsanalyser inom ett enskilt land och mellan olika länder.

Studie II

Rolfe, V., Strietholt, R., & Yang Hansen, K. (under revision). Does inequality in opportunity perpetuate inequality in outcomes? International evidence from four TIMSS cycles.

Litteraturen indikerar att elevernas socioekonomiska bakgrund och hur mycket ämnesinnehåll (eller Möjlighet att lära – OTL) de har påverkar resultatet betydligt. Syftet med Studie II var att observera socioekonomiska ojämlikheter i resultatet och möjlighet att lära, samt undersöka om skillnaden i möjligheter att lära medierar olikheter i resultatet. Dessa socioekonomiska ojämlikheter i resultat och i möjligheter åskådliggörs i en triangelformad OTL-SES-Prestation modell med data från 78 länder, undersökte studien sambandet mellan SES, OTL och prestation vid fyra cykler av TIMSS.

Studien fann att ojämlikheter i matematikresultat var nästan universella, men ojämlikheter i möjligheter var små och sällan betydande. Analysen gav litet belägg för att ojämlikheter i möjligheter medierar ojämlikheter i resultat. Skolgången fortsatte socioekonomiska ojämlikheter i endast en liten grupp länder. Dessa länder är rika och använder engelska som undervisningsspråk (t.ex. England, Skottland, Singapore). I Sverige, visade studien på ett prestationsgap vid varje tidpunkt, men ojämlikheter i möjligheter observeras endast i 2003 och 2015 års cykler. Dessutom, OTL medierade endast effekten av socioekonomisk bakgrund på resultat från 2003 års cykel i Sverige.

Studie III

Rolfe, V., Yang Hansen, K., & Strietholt, R. (under revision). Integrating educational quality and educational equity into a model of mathematics performance.

Den tredje studien fokuserar på att modellera likvärdighet i möjlighet att lära ur ett svenskt perspektiv. Då syftet med studien var att ge sammanhang till förståelsen om varför skolresultat skiljer sig mellan olika svenska skolor, Svenska data från årskurs 8 elever i TIMSS 2015 användes. I studien undersöks olikheter mellan klassrum genom att integrera lärare-egenskaper i den triangelformade SES-OTL-prestation modellen.

I första steget, undersökte studien skillnaden i lärarkvalitets-, prestations- och möjlighetsskillnader mellan klasser med högre eller lägre socioekonomisk sammansättning, och en korrelation mellan lärarkvalitet och lärares specialisering. I andra steget, visade studien olika mönster av olikheter mellan klasser med och utan en matematik-specialiserad lärare. I tvågruppsmodellens båda grupper fanns stora skillnader i prestation, medan skillnader i möjlighet att lära förbli i klasser med specialiserade lärare, men inte i klasser med icke-specialiserade lärare. Studie III betonar vikten av lärare av hög kvalitet för elevprestationer.

Diskussion och slutsatser

De empiriska studierna i denna avhandling visar vikten av att undersöka mätningen av likvärdighetsdefinierande begreppen. Flera tillvägagångssätt för mätningen av SES och OTL utforskas i avhandlingen. Dessa tillvägagångssätt hjälper till att bygga vår förståelse för både begreppen och nyttan av data från internationella storskaliga studier. Resultaten av denna avhandling belyser förekomsten av ihållande global socioekonomisk ojämlikhet i elevprestationer. De empiriska studierna visar inte att OTL förvärrar prestationsgap, men det finns fortfarande utrymme för att utforska detta förhållande. Slutligen fördjupar det empiriska arbetet i denna avhandling förståelsen för möjlighetsgapet i det svenska sammanhanget genom att visa att ojämlikhetsmönster varierar för specialiserade och icke-specialiserade lärare.

Olikvärdiga möjligheter är koncentrerat till högt utvecklade länder. De stora möjligheter som finns i engelsktalande länder tyder på att det kan finnas en distinkt kulturell norm inom Anglosfären när det gäller elevbakgrund och

genomförandet av läroplanen. Där det finns en betydande möjlighetsklyfta antyder denna avhandling att integrering av läraregenskaper kan förklara dessa ojämlikheter.

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Appendix A

Items used to indicate topic coverage in TIMSS

Table A1 Mathematics OTL topic coverage TIMSS 2003, 2007, 2011, 2015

Content Coverage: Number	**2003**	**2007**	**2011**	**2015**
Computations, estimations, or approximations involving whole numbers	•	•	•	•
Comparing and ordering rational numbers				•
Computing with rational numbers (fractions, decimals, and integers)				•
Concepts of irrational numbers				•
Computations with fractions	•	•	•	
Computations with decimals	•	•	•	
Representing, comparing, ordering, and computing with integers	•	•	•	
computation and Problem solving involving percents and proportions			•	•
Whole numbers including place value, factorization, and the four operations	•	•		
Common fractions including equivalent fractions and ordering of fractions	•	•		
Decimal including place value, ordering, and converting to common fractions (and vice versa)	•	•		
Representing decimals and fractions using words, numbers, or models (including number lines)	•	•		
Ratios (equivalence, division of a quantity by a given ratio)	•	•		
Conversion of percents to fractions or decimals and vice versa	•	•		
Content Coverage: Algebra	**2003**	**2007**	**2011**	**2015**
Simplifying or comparing algebraic expressions		•	•	•
Simple linear equations and inequalities			•	•
Simultaneous (two variables) equations			•	•
Numeric, algebraic, and geometric patterns or sequences (extension, missing terms, generalization of patterns)	•	•	•	•
Sums, products, and powers of expressions containing variables	•	•		
Evaluating expressions for given numeric value		•		
Modeling situations using expressions		•		
Evaluating functions/formulas for given values of the variables		•		
Simple linear equations and inequalities, and simultaneous (two variables) equations	•	•		
Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations	•	•	•	•
Properties of functions (slopes, intercepts, etc.)				•
Proportional, linear, and nonlinear relationships (travel graphs and simple piecewise functions included)	•			
Attributes of a graph such as intercepts on axes, and intervals where the function increases, decreases, or is constant	•			
Content Coverage: Geometry	**2003**	**2007**	**2011**	**2015**
Properties of geometric shapes: triangles, quadrilaterals, and other common polygons	•	•	•	•

Properties of other polygons (regular pentagon, hexagon, octagon, decagon)	•			
Properties of angle bisectors and perpendicular bisectors of lines	•			
Construct or draw triangles and rectangles of given dimensions	•			
Congruent figures (triangles, quadrilaterals) and their corresponding measures	•	•	•	•
Relationships between two-dimensional and three-dimensional shapes	•	•	•	•
Measurement formulas for perimeters, circumferences, areas of circles, surface areas, and volumes		•	•	•
Cartesian plane - ordered pairs, equations, intercepts, intersections, and gradient	•	•	•	•
Translation, reflection, and rotation	•	•	•	•
Angles - acute, right, straight, obtuse, reflex	•	•		
Relationships for angles at a point, angles on a line, vertically opposite angles, angles associated with a transversal cutting parallel lines, and perpendicularity	•	•		
Construct or draw triangles and rectangles of given dimensions		•		
Similar triangles and recall their properties	•	•		
Pythagorean theorem (not proof) to find length of a side	•	•		
Measurement, drawing, and estimation of the size of angles, the lengths of lines, areas, and volumes		•		
Measures of irregular or compound areas (e.g., by covering with grids or dissecting and rearranging pieces)		•		
Line and rotational symmetry for two-dimensional shapes	•	•		
Content Coverage: Data & Chance	**2003**	**2007**	**2011**	**2015**
Characteristics of data sets including mean, median, range, and shape of distribution (in general terms)	•	•		•
Reading data from tables, pictographs, bar graphs, pie charts, and line graphs		•	•	
Organizing and displaying data using tables, pictographs, bar graphs, pie charts, and line graphs	•	•		
Interpreting data sets (e.g., draw conclusions, make predictions, and estimate values between and beyond given data points)	•	•	•	•
Judging, predicting, and determining the chances of possible outcomes			•	•
Data displays that could lead to misinterpretation (e.g., inappropriate grouping and misleading or distorted scales)		•		
Using data from experiments to predict chances of future outcomes		•		
Using the chances of a particular outcome to solve problems		•		
Sources of error in collecting and organizing data (e.g., bias, inappropriate grouping)	•			
Data collection methods (e.g., survey, experiment, questionnaire)	•			
Drawing and interpreting graphs, tables, pictographs, bar graphs, pie charts, and line graphs	•			
Evaluating interpretations of data with respect to correctness and completeness of interpretation	•			
Simple probability including using data from experiments to estimate probabilities for favorable outcomes	•			

Table A2 Science OTL topic coverage TIMSS 2003, 2007, 2011, 2015

Content Coverage: Chemistry	**2003**	**2007**	**2011**	**2015**
Classification and composition of matter (physical and chemical characteristics, pure substances and mixtures, separation techniques)?	•	•	•	•
Structure of matter				•
Mixtures and solutions	•	•	•	•
Properties and uses of common acids and bases?	•	•	•	•
Chemical change (transformation of reactants,evidence of chemical change, conservation of matter)?	•	•	•	•
The role of electrons in chemical bonds				•
Particulate structure of matter (molecules, atoms,protons, neutrons, and electrons)?	•	•		
Properties and uses of water (composition, melting/boiling points, changes in density/volume)?	•	•		
The need for oxygen in common oxidation reactions (combustion, rusting) and the relative tendency of familiar substances to undergo these reactions?	•	•		
Classification of familiar chemical transformations as releasing or absorbing heat/energy?	•	•		
Content Coverage: Biology	**2003**	**2007**	**2011**	**2015**
Classification of organisms on the basis of a variety of physical and behavioral characteristics?	•	•		•
Major organ systems in humans and other organisms?	•	•	•	•
The human bodily processes	•	•		
Cell structures and functions?	•	•	•	•
Photosynthesis and respiration as processes of cells and organisms, including substances used and produced?	•	•		
The biology of plant and animal life	•	•		
Reproduction (sexual and asexual), and heredity (passing on of traits), inherited versus acquired/learned characteristics?	•	•	•	•
The role of variation and adaptation in survival/extinction of species in a changing environment?	•	•	•	•
Interdependence of populations of organisms in an ecosystem and factors affecting population size			•	•
Preventive medicine methods (diet, hygiene, exercise and lifestyle)?	•	•	•	•
Causes of common infectious diseases, methods of infection/transmission, prevention, and the body's natural resistance and healing capabilities?	•	•		
Reasons for increase in world's human population, and the effects of population growth on the environment?			•	
The interaction of living organisms in an ecosystem (energy flow, food chains and food webs, food pyramids, and the effects of change upon the system)?	•	•		
Cycling of materials in nature (water, carbon/oxygen cycle, decomposition of organisms)	•	•		
Trends in human population and its effects on the environment		•		
The impact of natural hazards on humans, wildlife, and the environment		•		
Content Coverage: Physics	**2003**	**2007**	**2011**	**2015**
Physical states and changes in matter (explanations of properties including volume, shape, density, and compressibility in terms of movement/distance between particles)?	•	•	•	•
Energy types	•	•	•	•

Basic properties/behavior of light (reflection, refraction, light and color, simple ray diagrams)?	•	•	•	•
Properties of sound (production by vibration,transmission through media, ways of describing sound (intensity, pitch), relative speed)?	•	•		
Electric circuits (flow of current, types of circuits -open/closed, parallel/series) and relationship between voltage and current?	•	•	•	•
Forces and motion (types of forces, basic description of motion), use of distance/time graphs?	•	•	•	•
Properties of permanent magnets and electromagnets?	•	•		
Effects of density and pressure?	•	•		
Processes of melting, freezing, evaporation, and condensation (phase change; melting/boiling points; effects of pressure and purity of substances)	•	•		
Heat and temperature	•	•		
Content Coverage: Earth Science	**2003**	**2007**	**2011**	**2015**
Earth's structure and physical features (Earth's crust, mantle, and core; topographic maps)?	•	•	•	•
The earth's processes and history			•	•
Use and conservation of natural resources (renewable/non-renewable resources, human use of land/soil and water resources)?	•	•	•	•
The earth in the solar system and the universe			•	•
The physical state, movement, composition, and relative distribution of water on the Earth?	•	•		
The Earth's atmosphere and the relative abundance of its main components?	•	•		
Earth's water cycle (steps, role of sun's energy, circulation/renewal of fresh water)?	•	•		
Processes in the rock cycle and the formation if igneous, metamorphic, and sedimentary rock?	•	•		
Weather data/maps, and changes in weather patterns (e.g., seasonal changes, effects of latitude, altitude and geography)?	•	•		
Geological processes occurring over billions of years (e.g., erosion, mountain building, plate movement)?	•	•		
Formation of fossils and fossil fuels?	•	•		
Food supply and production		•		
Relationship of land management (e.g., pest control) to human use (e.g., farming) and demand of fresh water resources		•		
Explanation of phenomena on Earth based on position/movement of bodies in the solar system and universe (e.g., day/night, tides, year, phases of the moon, eclipses, seasons, appearance of sun, moon, planets, and constellations)?	•	•		
The physical features of Earth compared with the moon and other planets (e.g., atmosphere, temperature, water, distance from sun, period of revolution/rotation, ability to support life)?	•	•		
The sun as a star?	•			
Trends in human population and its effects on the environment?	•			
Changes in environments (role of human activity, effects/prevention of pollution, global environmental concerns, impact of natural hazards)?	•			
Environmental concerns (e.g., pollution, global warming, acid rain)		•		

Appendix B

Study III – questionnaire items used within variable parcels

Table B1 TIMSS 2015 student questionnaire items indicating SES in Study III

Grouped variable	Item
Home possessions	Number of books in the home
	Highest parental education
	Own computer
	A omputer at home
	A desk
	Own room
	Internet connection
	Own mobile phone
	A gaming system
	A globe
	A piano
	Another instrument

Table B2 TIMSS 2015 teacher questionnaire items indicating content coverage in Study III

Grouped variable	Question: When have students in this class have been taught each of the following mathematics topics?
CC: Number	Computing with whole numbers Comparing and ordering rational numbers Computing with rational numbers Concepts of irrational numbers Problem solving involving percents or proportions
CC: Algebra	Simplifying and evaluating algebraic expressions Simple linear equations and inequalities Simultaneous (two variables) equations Numeric, algebraic, and geometric patterns or sequences Representation of functions as ordered pairs, tables, graphs, words, or equations Properties of functions
CC: Geometry	Geometric properties of angles and geometric shapes Congruent figures and similar triangles Relationship between three-dimensional shapes and their two-dimensional representations Using appropriate measurement formulas for perimeters, circumferences, areas, surface areas, and volumes Points on the Cartesian plane Translation, reflection, and rotation
CC: Data & Chance	Characteristics of data sets Interpreting data sets Judging, predicting, and determining the chances of possible outcomes

Table B3 TIMSS 2015 teacher questionnaire items indicating preparedness to teach in Study III

Grouped variable	Question: How well prepared do you feel you are to teach the following mathematics topics?
PT: Number	Computing with whole numbers Comparing and ordering rational numbers Computing with rational numbers Concepts of irrational numbers Problem solving involving percents or proportions
PT: Algebra	Simplifying and evaluating algebraic expressions Simple linear equations and inequalities Simultaneous (two variables) equations Numeric, algebraic, and geometric patterns or sequences Representation of functions as ordered pairs, tables, graphs, words, or equations Properties of functions
PT Geometry	Geometric properties of angles and geometric shapes Congruent figures and similar triangles Relationship between three-dimensional shapes and their two-dimensional representations Using appropriate measurement formulas for perimeters, circumferences, areas, surface areas, and volumes Points on the Cartesian plane Translation, reflection, and rotation
PT: Data & Chance	Characteristics of data sets Interpreting data sets Judging, predicting, and determining the chances of possible outcomes

Table B4 TIMSS 2015 teacher questionnaire items indicating school emphasis on academic success in Study III

Grouped variable	Question: How would you characterize each of the following within your school?
SEAS: Teachers	Teachers' understanding of the school's curricular goals
	Teachers' degree of success in implementing the school's curriculum
	Teachers' expectations for student achievement
	Teachers working together to improve student achievement
	Teachers' ability to inspire students
SEAS: Parents	Parental involvement in school activities
	Parental commitment to ensure that students are ready to learn
	Parental expectations for student achievement
	Parental support for student achievement
	Parental pressure for the school to maintain high academic standards
SEAS: Students	Students' desire to do well in school
	Students' ability to reach school's academic goals
	Students' respect for classmates who excel in school
SEAS: School	Clarity of the school's educational objectives
	Collaboration between school leadership and teachers to plan instruction
	Amount of instructional support provided to teachers by school leadership
	School leadership's support for teachers' professional development

Appendix C

Reliability testing

Table C1 Reliability testing Study I

	2000	2003	2006	2009	2012	2015
Desk						
Study space						
Text-books						
Dictionary						
Educational Software						
Own Room						
Internet	.601	.667	.601	.607	.614	.624
Classic Literature						
Poetry						
Art						
Books*						
Parental Education						

Table C2 Reliability testing for OTL measures in Study II

	2003		2007		2011		2015	
	Maths	Science	Maths	Science	Maths	Science	Maths	Science
Algeria			.797	.854				
Australia	.883	.910	.903	.906	.821	.775	.786	.759
Bahrain	.697	.795	.826	.776	.771	.834	.888	.733
Armenia	.768	.839	.974	.886	.702	.637	.638	.585
Bosnia and Herzegovina			.789	.887				
Botswana	.833	.738	.932	.902	.747	.730	.765	.695
Bulgaria	.749	.751	.856	.821				
Canada							.766	.710
Chile	.893	.872			.824	.730	.790	.749
Chinese Taipei	.790	.874	.872	.935	.703	.824	.581	.873
Colombia			.908	.902				
Cyprus	.742	.889	.757	.858				
Czech Republic			.740	.826				
El Salvador			.864	.881				
Estonia	.826	.733						
Finland					.486	.670		
Georgia			.805	.763	.662	.754	.682	.530
Palestinian National Authority	.688	.873	.884	.868	.669	.712		
Ghana	.864	.812	.908	.888	.766	.791		
Honduras					.819	.787		
Hong Kong	.787	.832	.777	.869	.682	.720	.580	.683
Hungary	.885	.886	.785	.801	.634	.676	.737	.746
Indonesia	.762	.887	.823	.879	.668	.652		
Iran	.830	.882	.830	.844	.673	.569	.684	.757
Ireland							.746	.577
Israel	.826	.855	.894	.859	.738	.759	.744	.863
Italy	.793	.837	.793	.841	.612	.617	.644	.718
Japan	.819	.669	.825	.781	.525	.475	.593	.752
Kazakhstan							.752	.667
Jordan	.831	.898	.886	.916	.750	.805	.777	.779
Korea, Republic of	.917	.893	.857	.898	.811	.653	.758	.757
Kuwait			.893	.937			.731	.794
Lebanon	.816	.834	.897	.868	.802	.773	.779	.724
Latvia	.622	.719						
Lithuania	.583	.845	.718	.651	.458	.697	.529	.886
Malaysia	.836	.815	.930	.913	.789	.699	.808	.810
Malta			.870	.851			.811	.911

	2003		2007		2011		2015	
	Maths	**Science**	**Maths**	**Science**	**Maths**	**Science**	**Maths**	**Science**
Mongolia			.851	.964				
Moldova	.913	.845						
Morocco	.832	.722	.874	.865	.714	.538	.678	.596
Oman			.852	.890	.719	.716	.710	.774
Netherlands	.857	.745						
New Zealand	.872	.848			.825	.789	.837	.810
Norway	.755	.838	.794	.864	.710	.777	.531	.598
Qatar			.843	.881	.865	.818	.839	.778
Philippines	.903	.941						
Romania	.807	.804	.863	.919	.637	.749		
Russia								
Saudi Arabia	.712	.864	.855	.834	.870	.745	.836	.772
Singapore	.864	.889	.860	.905	.672	.771	.741	.800
Slovak Republic	.747	.729						
Slovenia	.718	.890	.641	.863	.521	.685	.602	.834
South Africa	.893	.942			.813	.844	.903	.886
Sweden	.837	.912	.829	.877	.690	.518	.692	.574
Syria	.788	.865	.765	.902	.796	.729		
Thailand			.885	.902	.805	.781	.810	.800
United Arab Emirates					.785	.795	.839	.756
Tunisia	.901	.887	.775	.891	.738	.737		
Turkey			.874	.924	.753	.674	.705	.704
Ukraine			.667	.722	.603	.430		
Macedonia	.688	.885			.654	.677		
Egypt	.626	.835	.855	.870			.610	.723
United States	.930	.916	.667	.722	.603	.430	.807	.821
Serbia	.934	.865	.795	.893				
England	.919	.943	.933	.926	.844	.910	.819	.920
Scotland	.874	.795	.924	.864				
Belgium (Flemish)	.882	.782						
Spain (Basque Country)	.904	.867	.880	.871				
UAE (Dubai)			.862	.922	.785	.827	.818	.779
UAE (Abu Dhabi)					.720	.786	.772	.755
Canada (Ontario)	.873	.880	.902	.868	.852	.738	.842	.726
Canada (Quebec)	.845	.856	.801	.842	.623	.670	.611	.674

	2003		2007		2011		2015	
	Maths	**Science**	**Maths**	**Science**	**Maths**	**Science**	**Maths**	**Science**
Canada (Alberta)					.750	.707		
Canada (British Columbia)			.914	.936				
United States (MA)			.945	.875				
United States (MN)			.907	.953				
United States (IN)	.935	.885						
Argentina, Buenos Aires							.892	.893
Average	.817	.843	.843	.868	.718	.712	.738	.751

Table C3 Reliability testing of constructs in Study III

Construct	Items/Parcels	Cronbach's Alpha
	Student Level	
SES	Books Parental Education Home possessions*	.582
	Teacher Level	
SES	Aggregated Books Aggregated Parental Education Aggregated Home possessions*	.832
OTL	Content Coverage: Number* Content Coverage: Algebra* Content Coverage: Geometry* Content Coverage: Data & Chance*	.520
Teacher Quality	Years of Teaching Experience* Preparedness to Teach: Number* Preparedness to Teach: Algebra* Preparedness to Teach: Geometry* Preparedness to Teach: Data & Chance*	.832
SEAS	School Emphasis on Academic Success: Teachers* School Emphasis on Academic Success: Parents* School Emphasis on Academic Success: Students* School Emphasis on Academic Success: School*	.725

Table C4 Reliability testing within variable parcels, Study III

	Cronbach's Alpha
Student Questionnaire items	
Home possessions Own computer A omputer at home A desk Own room Internet connection Own mobile phone A gaming system A globe A piano Another instrument	.407
Teacher questionnaire items	
Content Coverage: Number[a]	
Computing with whole numbers Comparing and ordering rational numbers Computing with rational numbers Concepts of irrational numbers Problem solving involving percents or proportions	.679
Content Coverage: Algebra[a]	
Simplifying and evaluating algebraic expressions Simple linear equations and inequalities Simultaneous (two variables) equations Numeric, algebraic, and geometric patterns or sequences Representation of functions as ordered pairs, tables, graphs, words, or equations Properties of functions	.633
Content Coverage: Geometry[a]	
Geometric properties of angles and geometric shapes Congruent figures and similar triangles Relationship between three-dimensional shapes and their two-dimensional representations Using appropriate measurement formulas for perimeters, circumferences, areas, surface areas, and volumes Points on the Cartesian plane Translation, reflection, and rotation	.443
Content Coverage: Data & Chance[a]	
Characteristics of data sets Interpreting data sets Judging, predicting, and determining the chances of possible outcomes	.571
Preparedness to Teach: Number[b]	
Computing with whole numbers Comparing and ordering rational numbers Computing with rational numbers Concepts of irrational numbers Problem solving involving percents or proportions	.834

	Cronbach's Alpha
Preparedness to Teach: Algebra[b]	
Simplifying and evaluating algebraic expressions	
Simple linear equations and inequalities	
Simultaneous (two variables) equations	
Numeric, algebraic, and geometric patterns or sequences	.853
Representation of functions as ordered pairs, tables, graphs, words, or equations	
Properties of functions	
Preparedness to Teach Geometry[b]	
Geometric properties of angles and geometric shapes	
Congruent figures and similar triangles	
Relationship between three-dimensional shapes and their two-dimensional representations	.833
Using appropriate measurement formulas for perimeters, circumferences, areas, surface areas, and volumes	
Points on the Cartesian plane	
Translation, reflection, and rotation	
Preparedness to Teach: Data & Chance[b]	
Characteristics of data sets	
Interpreting data sets	.800
Judging, predicting, and determining the chances of possible outcomes	
SEAS: Teachers[c]	
Teachers' understanding of the school's curricular goals	
Teachers' degree of success in implementing the school's curriculum	
Teachers' expectations for student achievement	.786
Teachers working together to improve student achievement	
Teachers' ability to inspire students	
SEAS: Students[c]	
Students' desire to do well in school	
Students' ability to reach school's academic goals	.741
Students' respect for classmates who excel in school	
SEAS: Parents[c]	
Parental involvement in school activities	
Parental commitment to ensure that students are ready to learn	
Parental expectations for student achievement	.788
Parental support for student achievement	
Parental pressure for the school to maintain high academic standards	
SEAS: School[c]	
Clarity of the school's educational objectives	
Collaboration between school leadership and teachers to plan instruction	.848
Amount of instructional support provided to teachers by school leadership	
School leadership's support for teachers' professional development	

NB [a]Question: When have students in this class have been taught each of the following mathematics topics?; [b]Question: How well prepared do you feel you are to teach the following mathematics topics?; [c]Question: How would you characterize each of the following within your school?

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GOTHENBURG STUDIES IN EDUCATIONAL SCIENCES 462

Socioeconomic inequality of outcomes is a perennial concern in educational science. This thesis explores a network of educational inequalities relating to student achievement in international assessment. Grounded in the understanding of curricula as experiences, the thesis investigates how outcomes are influenced by actions in the classroom. Previous research posits that student background, the amount of exposure to subject content, and teacher characteristics significantly influence student outcomes.

The thesis presents three empirical studies, drawing on data from international large-scale assessments. Study I examined the measurement of socioeconomic status over time in Sweden. Study II investigated achievement and opportunity gaps in mathematics and science and whether unequal opportunities perpetuate unequal outcomes from an international perspective, while multiple inequalities in Swedish classrooms were explored in Study III. Collectively, the findings of the constituent studies confirm the persistence of the achievement gap in Sweden and globally, contextualize the opportunity gap in Sweden, and underline the importance of item choice and construct measurement when modelling inequality using international data.

Victoria Rolfe holds a M.Sc. in Education, and has previously taught English abroad. Her research interests focus on equality in education and educational measurement.

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