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Perseverance, Passion and Poverty: Examining the association between grit and reading achievement in high-poverty schools in South Africa

Heleen Hofmeyr^{1,2}

Abstract:

This paper examines whether school characteristics moderate the association between grit and reading achievement in a sample of Grade 6 learners in high-poverty contexts. The analysis makes use of data from 2,383 learners distributed across 60 township and rural schools in three provinces of South Africa. Indicators of school functionality are used to split the sample of schools into three groups (low, medium, and high functionality) and separate models of reading achievement are estimated for each group. The econometric analysis points to evidence of variation in the association between grit and reading achievement by school functionality, with a stronger association estimated for learners in more functional schools. The major contributions of this paper are as follows: Firstly, this paper is one of only a handful of studies that estimate the relationship between grit and academic achievement in a middle-income country, and the first to estimate this relationship among primary school learners in an African context. Second, the results provide empirical evidence in support of the hypothesis that school characteristics interact with non-cognitive skills to produce learning outcomes, a relationship that has received scant attention in the literature to date.

1. Introduction

Two decades of research has shown that socio-emotional skills (also referred to as noncognitive skills, character skills, soft skills, etc. (Peña and Duckworth, 2018)) are highly predictive of a number of important life outcomes, including educational attainment (Heckman and Kautz, 2012). Economists who study socio-emotional skills have relied heavily on constructs from psychology, where the relationship between socio-emotional skills and academic achievement has been studied for over a century (Almlund *et al.*, 2011). One line of enquiry within this latter tradition that has received much attention both in public discourse and among education researchers in recent years is the work of Duckworth and colleagues (2007), who have presented the construct of “grit” as a personality trait that is highly predictive of academic performance (Poropat, 2009). Grit is defined as “perseverance and passion for long-term goals” and “entails working strenuously toward challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress” (Duckworth *et al.*, 2007: 1087-1088). Perhaps due to the intuitive appeal of the idea that academic performance results from the combination of hard work and maintained interest, especially in the face of adversity, there has been much public debate around the idea that fostering grit could be an effective strategy for raising learning outcomes in contexts of socio-economic deprivation (Tough, 2011, 2016; Perkins-Gough, 2013; McKenzie, 2016; Ris, 2016; Huang and Zhu, 2017).

Perhaps the most often cited criticism of the idea that grit underlies academic success is the argument that systemic inequality, and not lack of effort on the part of individual students, is the root of

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underachievement in schools. A second, related criticism is that almost all evidence of the relationship between grit and academic achievement is based on studies conducted with middle-class and upper-middle-class students in high-income countries. Many have questioned the relevance of these findings for education policy in low- and middle-income countries, where students often face the double burden of socio-economic home disadvantage and poor-quality education. While there have been a handful of interventions aimed at fostering grit among socio-economically disadvantaged students in the US, evidence of the association between grit and academic achievement in high-poverty contexts is thin. Moreover, there is a dearth of evidence of this relationship from developing countries.

This paper aims to provide evidence of the predictive power of grit in high-poverty contexts by examining the relationship between grit and academic achievement among a sample of Grade 6 students from rural and township primary schools in South Africa. It will be made evident that while the perseverance subscale of grit is a strong predictor of student achievement, even when controlling for a host of factors at the individual, home and school level, there is strong evidence to suggest that structural factors such as school functionality moderate the association between perseverance and achievement. This evidence leads to the conclusion that while grit may be important for academic success in high-poverty contexts, focusing on the development of students' socio-emotional skills should not detract from efforts to remedy systemic failures in education systems.

2. Background

2.1. Socio-emotional skills and economics

The term socio-emotional skills is used interchangeably with “noncognitive” skills in the economics literature (Puerta and Valerio, 2016). Within this literature, the term is used to refer to all the “personality traits, goals, character traits, motivations, and preferences that are valued in the labour market, in school, and in many other domains” (Kautz *et al.*, 2014: 2). Economists have studied socio-emotional skills for two decades, resulting in a body of work which is broadly termed the skill formation literature, or the economics of human development. This research tradition began largely as the result of the work of James Heckman and colleagues who have shown that socio-emotional skills are highly predictive of life outcomes that are of interests to economists, such as educational attainment and success in the labour market. This result has become conventional wisdom in labour economics, and has spawned research interest among economists regarding how socio-emotional skills are formed. The finding from developmental psychology and neuroscience that both cognitive and socio-emotional skills are determined by an interaction between genetics and the developing child's environment (Heckman, 2006) has led to particular research interest in children's developmental environments among economists. Early childhood education, in particular, has received much attention as a key policy lever for improving social outcomes. Durlak *et al.* (2011) present a comprehensive summary of this literature.

A related but separate research tradition in economics is the school effectiveness literature, where education production functions (EPFs) are typically used to model learning outcomes as a function of key inputs at the school level. This methodology stems from economists' motivation behind studying the learning process, namely understanding how best to allocate resources in education (Hanushek, 1968). While it is standard practice in school effectiveness research to include non-school factors in EPFs, this is done in order to improve the precision with which the primary associations of interest – that between school characteristics and student achievement – are estimated. That is, non-school factors that are likely to affect achievement are usually controlled for in school effectiveness studies with the goal of better parsing out the relationships between school characteristics – which can be affected by public spending – and achievement.

In this sense, it may seem unusual to include student characteristics such as socio-emotional skills as the primary covariates of interest in EPFs. Doing so requires conceiving of socio-emotional skills as educational inputs that are amenable to policy intervention. In fact, it is precisely because of the difficulty of conceiving of socio-emotional skills in this way that the role of these skills in shaping learning outcomes has received relatively little attention in school effectiveness research. The very first studies that used the EPF approach to model student achievement (those of Coleman *et al.*, (1966) and Hanushek (1968)) included measures of student “attitudes”³ and found significant associations between these variables and achievement. However, these associations were deliberately de-emphasised given that very little was known about how to foster socio-emotional skills at the time. In one of these studies, Hanushek (1968: 85) argued that “even less is known about the attitude formation process than about the educational production process”, and concluded that “at least in the short run, attitudes are not a key element of the (educational production function) model for policy purposes.” As the more recent findings from the skill formation literature have shed light on the technology of skill formation, however, and shown that targeted interventions can effectively improve socio-emotional skills, one would be hard-pressed still to argue that socio-emotional skills should not be a key element of EPFs for policy purposes. While a growing number of authors have recognised this and, as a result, have included socio-emotional skills in EPFs, this research is in its infancy. Importantly, there is a dearth of evidence of the predictive power of socio-emotional skills in EPFs from low- and middle-income countries. In addition, only a handful of studies have considered potential interaction effects between school characteristics and socio-emotional skills in influencing learning outcomes. This paper aims to add to the growing body of work on socio-emotional skills in studies of school effectiveness by including grit in an EPF model of student achievement using data from high-poverty contexts in South Africa, and investigating whether the association between grit and achievement differs by school characteristics.

2.2. Grit and student achievement

Psychologists have studied the role of socio-emotional skills in determining learning outcomes for over a century (Almlund *et al.*, 2011). The motivation behind this line of inquiry, however, has been explaining individual differences in learning outcomes (Almlund *et al.*, 2011), which is fundamentally different from economists’ objective of understanding how best to allocate resources in education. These different motivations for studying the same process inevitably lead to differences between psychologists and economists in their approaches to studying this process. Since each discipline comes with its own set of underlying theories and research methodologies, it is not clear how economists should interpret the findings from the psychological literature regarding the relationship between socio-emotional skills and achievement. This is especially true for studies of the association between grit and student achievement, given that all existing peer-reviewed studies of this association have been conducted by psychologists.

One major point of divergence between the approaches of economists and psychologists to studying the role of socio-emotional skills in learning processes is the modelling approaches used by each of these disciplines. In particular, psychologists’ focus on individual differences in achievement has meant that they rarely try to parse out the relationship between socio-emotional skills and achievement while keeping school quality constant (Almlund *et al.*, 2011). This contrasts with convention in the school effectiveness literature of controlling for a host of factors in order to isolate associations between school characteristics and learning outcomes. Existing findings of the association between grit and achievement

³ Hanushek uses the term “attitudes” to refer to student characteristics that would today be termed socio-emotional skills, such as locus of control and educational aspirations.

therefore do not control for school quality, with the exception of a study by Tovar García (2017), who controls for school characteristics when estimating the association between grit and achievement among a sample of Grade 9 students in Russia.

A second point of divergence in the approaches of economists and psychologists to studying the role of socio-emotional skills in the learning process is the samples of students used to investigate this question. Since psychologists typically collect primary data, their sample sizes are constrained by cost considerations. Consequently, most existing studies of the association between grit and academic achievement use samples that do not exceed 500 students. Exceptions to this include the studies of Eskreis-Winkler *et al.* (2014), Huang and Zhu (2017), and Kool *et al.* (2018), Bowman *et al.* (2015) and West *et al.*, (2016). Economists, on the other hand, typically make use of secondary data such as standardised achievement tests which are administered to large samples of students. Larger datasets are limited, however, in that they rarely include detailed measures of socio-emotional skills⁵.

Given these features of the methodological approaches employed in psychologists' studies of the association between grit and student achievement, it is unsurprising that perhaps the most often cited criticism of the idea that grit underlies academic success is the fact that these studies do not account for structural factors that influence achievement, such as unequal access to resources, differences in the quality of leadership and management in schools, and differences in how much time children spend learning (Kundu, 2014; Gonzales Stokas, 2015; Golden, 2017; Credé, 2018; Morton and Paul, 2019). These critics argue that these structural inequalities, and not lack of effort on the part of individual students, are at the root of underachievement in schools. The hypothesis implied by this line of argument is that these structural inequalities between schools limit the power of grit in predicting student achievement. This hypothesis is a version of the "Matthew effect" hypothesis, since it posits that grit will be a stronger predictor of achievement among students who already have the advantage of being in more functional schools. Damian *et al.* (2015) put forward two alternative potential hypotheses regarding the interaction of student characteristics and systemic factors, namely the independent effects hypothesis and the resource substitution hypothesis. According to the independent effects hypothesis, there would be no variation in the relationship between grit and achievement by school functionality, that is, grit would have the same predictive power in all types of schools. According to this hypothesis, grit will not interact with school characteristics to produce learning outcomes. The resource substitution hypothesis, on the other hand, predicts that grit will be a stronger predictor of achievement among students in less functional schools. According to the latter hypothesis, socio-emotional skills such as grit can serve as substitutes for school resources in the learning process in contexts where school resources are scarce.

This paper aims to identify which of these three hypotheses is supported by data from South Africa. The data used in this study is particularly suited to investigating this question due to the contexts of severe socio-economic deprivation that characterise the schools in the sample. In addition, the contexts that characterise the data used in this study are similar to the contexts that characterise much of the developing world. In this sense, estimating potential moderating effects of school characteristics on the association between grit and achievement using this sample of students may provide important insights

⁵ While large-scale educational assessments such as the Progress in Reading Literacy Study (PIRLS) and the Trends in Mathematics and Science Study (TIMSS) increasingly include measures of student engagement and attitudes in their student background questionnaires, the construct validity of these measures have been called into question by a number of authors (for example Hooper *et al.* (2013), Liou (2014) and Marsh *et al.* (2013)).

regarding these effects for students who face similar socio-economic disadvantage in other parts of the world.

3. Data and methodology

3.1. Data

The data used was gathered for a project entitled “Leadership for Literacy”⁶, which was aimed at understanding resilience and exceptionalism in high-functioning township and rural primary schools in South Africa. In 2017, literacy tests were administered to over 2600 grade 6 students in 60 primary schools. The Leadership for Literacy project was aimed specifically at identifying exceptional schools matched to underperforming pairs in challenging contexts, so the sample consists only of schools located in township or rural areas (for further discussion of the sampling process see Taylor, Wills, & Hoadley (2019)). The sample is representative neither at the national nor provincial level. Nevertheless, due to the matched schools design on which the sampling process was based, and the wide geographic dispersion of these schools within provinces, they are a close representation of schools in socio-economically disadvantaged areas in three provinces of South Africa (KwaZulu-Natal, Limpopo and Gauteng).

Most quantitative studies of education in South Africa use assessment data from only one point in time. However, there is consensus in the international literature that such cross-sectional assessment data are subject to considerable measurement error (Agostinelli, Saharkhiz and Wiswall, 2019). A key advantage of the Leadership for Literacy data is that the reading and literacy assessments were administered twice, at the beginning of the school year and again towards the end of the same school year. The pre- and post-test have high levels of reliability. The longitudinal dimension of the Leadership for Literacy assessment data offers a unique opportunity to reduce measurement error in reading scores which most quantitative studies of education in South Africa have not been able to do. The assessment consisted of a silent reading comprehension test that was administered to an entire class of Grade 6 students in each school. Of the original pre-test sample of 2 656 students, 2 383 wrote the post-test, indicating a low attrition rate of 11%. The two comprehension tests consisted of released items from previous rounds of the grade 4 PIRLS assessment. Permission was received from the IEA for their use.

The tests were conducted in English and in this respect reading achievement in this study is largely defined in terms of reading achievement in English. This may be criticised as a measure of overall reading achievement since students may perform badly in English reading but well in other subjects or languages. However, English language proficiency is a necessary condition for academic success in South African schools, for although schools are at liberty to choose one of the 11 official languages as their medium of instruction in foundation phase grades (Grades R-3)⁷, all are required to teach in English or Afrikaans from Grade 4 onwards. If children cannot read and write in English by the end of Grade 3, it is very difficult for them to access the curriculum.

In addition to the comprehension tests, the research team also administered student background questionnaires and collected information about school characteristics through fieldworker observations. Information from both the student background questionnaires and fieldworker observations was used to derive the individual, home and school variables included in the multivariate analysis.

⁶ This project was funded by the UK’s Economic and Social Research Council (grant ES/N01023X/1).

⁷ Grade R is the “reception” year in South Africa, that is, the grade preceding Grade 1, equivalent to Kindergarten in the United States.

3.2. Measures

In the main model, reading performance is measured as the mean silent comprehension test score between the pre-test and the post-test. Students could score a maximum of 32 points in the silent comprehension test. Raw comprehension scores were standardized for ease of interpretation. Student grit is measured using responses to an adapted version of the short grit scale (Grit-S) (Duckworth and Quinn, 2009), where students had to rate themselves on eight items, choosing from “That’s not at all like me”, “That’s not really like me”, “That’s sometimes like me”, and “That’s a lot like me”.

The measure of school functionality included in the multivariate analysis is derived from fieldworker observations. This measure includes information about school infrastructure, learning materials, and instructional time. Principal components analysis was used to derive an index of school functionality based on 10 of these measures. The index has a high scale reliability coefficient of 0.70. This index was used to split the sample into terciles of school functionality, each containing 20 schools. Due to larger class sizes in the bottom tercile, there are more students in the bottom tercile (868 students) compared to the second and third terciles (743 and 772 students in each tercile, respectively). Table 1 shows differences between these three groups of schools in terms of the variables included in the school functionality index at the school and classroom level, respectively. The proportions shown are calculated at the student level. The figures show that even though all the schools in the sample are no-fee schools⁸, there is significant variation in functionality between the three groups of schools. For example, while less than 10 percent of students in the bottom tercile attended schools where most toilets worked, this proportion was 85 percent for students in the top functionality tercile. Differences in the proportions of students in classes that exceeded 50 students (the variable labelled “large class” in Table 1) is particularly striking, with almost half (47 percent) of students in the bottom tercile of schools being in such large classes, and none of the Grade 6 classes in the top tercile exceeding 50 students. It is important to note that large classes can be considered a measure of school functionality, and not simply school resources, in that they indicate how teachers are utilised in terms of time-tabling within schools. All the schools in the sample are no-fee schools and would therefore not have been able to appoint extra teachers with school governing body funds. Since teacher allocations are based on enrolments, the number of teachers in each school should – at least theoretically – be proportional to the number of students. It is in this sense, then, that differences in class sizes reflect differences in the effectiveness with which school resources – in this case, teachers – are utilised. The effects of such large classes are reflected in the variables indicating whether the Grade 6 classrooms were cramped, whether there were not enough chairs or desks for all students, and whether there were enough textbooks for all students, with these proportions decreasing with school functionality tercile.

⁸ No-fee schools constitute the poorest roughly 60% of schools in South Africa (referred to as Quintile 1-3 schools), which are typically under-resourced and characterized by legacies of dysfunction (Wills, 2017). School quintiles were originally constructed using Census information on the infrastructural development of the surrounding area to inform student funding allocations in a pro-poor manner. These schools are technically not allowed to charge fees due to the relative poverty of the communities they serve and the South African Constitution’s commitment to providing free basic education.

Table 1: School and classroom characteristics by functionality tercile

	Tercile 1	Tercile 2	Tercile 3
Library	22%	62%	89%
Most toilets work	7%	56%	85%
Teachers missing	29%	41%	34%
School-wide reading period	17%	26%	51%
Large class	47%	21%	0%
Classroom cramped	42%	24%	12%
Not enough chairs	99%	40%	11%
Not enough desks	95%	44%	12%
Desks broken	59%	24%	6%
Enough textbooks	32%	55%	61%

Notes: “Teachers missing” indicates whether at a certain point during the school day, fieldworkers observed any classes where students were present but there was no teacher in the classroom. “School-wide reading period” indicates whether the school timetable included a daily period dedicated to reading. “Large class” indicates whether there were more than 50 students in the Grade 6 class participating in the study (derived from the number of students who wrote the literacy assessment in each Grade 6 class).

Student wealth was measured using information about 11 assets students indicated having in their homes in the student background questionnaire. The proportions of students who indicated they have certain assets in their homes is shown in Table 2. It is clear from the figure that although the sample of schools was purposefully chosen to represent students from low socio-economic backgrounds, there is significant variation in material resources in the homes of the students in the Leadership for Literacy sample. It is further evident from Table 2 that this variation is highly correlated with school functionality, with students in the bottom school tercile facing more resource deprivation at home, on average. For example, while only 11 percent of students in the bottom tercile of schools indicated that they had running water in their homes, this proportion was 39 percent for students in the top school tercile. Similarly, only 24 percent of tercile 1 students indicated having a flush toilet in their homes, whereas 59 percent of tercile 3 students did so. In addition to significant variation in the material wealth of students in the Leadership for Literacy sample by school functionality, Table 2 also points to the severity of resource deprivation faced by the students in this sample overall, providing further motivation for using this sample to study the association between grit and achievement in high-poverty contexts. Principal components analysis was used to derive an index of these 11 assets, which is used as the measure of student SES in the multivariate analysis. This index also has a high scale reliability coefficient, at 0.79. While it is standard practice in the literature to include information on parental education in measures of student SES, unfortunately information on parental education was not collected in the Leadership for Literacy student background questionnaire. The measure of student SES used in the analysis that follows is therefore strictly a measure of material wealth. The SES of a school’s student body was taken as the mode of this asset index score for the Grade 6 pupils in that school.

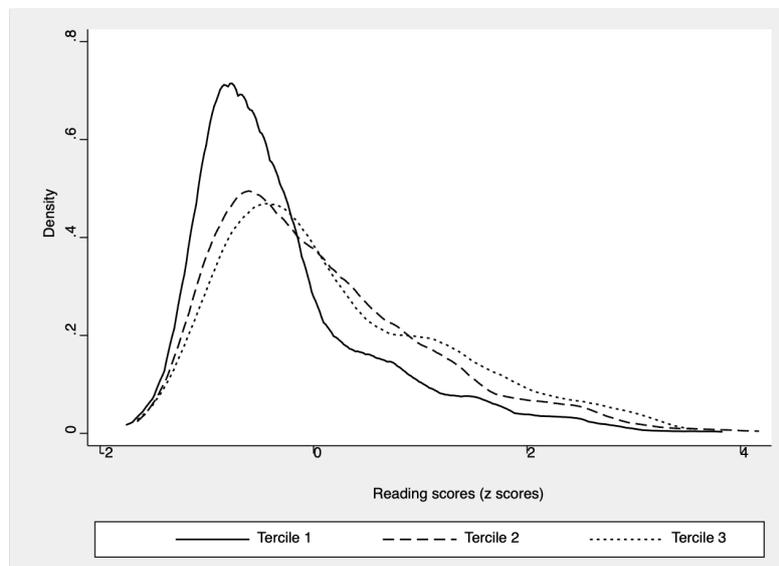
Table 2: Home assets by school functionality tercile

	Tercile 1	Tercile 2	Tercile 3
Cell phone	94%	97%	97%
Fridge	86%	92%	96%
TV	86%	93%	98%
Microwave	55%	69%	80%
Car	52%	59%	64%
Running water	39%	71%	81%
Running water (hot)	11%	26%	35%
Internet	40%	43%	53%
Computer	35%	45%	50%
Washing machine	28%	54%	61%
Toilet	24%	54%	59%

Notes: Information about home assets was collected in the student background questionnaire. Students had to tick which assets they had in their home from a list. Pictures were included to minimize the potential effect of low literacy on the accuracy with which students responded to these questionnaire items.

Figure 1 shows the distribution of reading scores for each tercile of school functionality. As expected, the distribution of comprehension test scores of students in the bottom school tercile lies clearly to the left of the other two terciles of school functionality. It is interesting to note, however, that there is little variation in the distributions of reading scores of students in the second and third terciles.

Figure 1: Kernel density distribution of reading scores by school functionality tercile



4. Measuring grit

Before attempting to investigate the main research question of this paper, it is necessary to assess the reliability with which grit is measured in the Leadership for Literacy sample of students. Of particular concern is that participating students in the Leadership for Literacy sample may not have the required literacy skills to answer questionnaire items meaningfully. These items were administered by paper and pen (not through oral face-to-face interviews). This is a concern that plagues all studies that use information from student background questionnaires. However the question of how low literacy may affect responses in such questionnaires has received very little attention in the literature. Part of the reason for this may be that large-scale educational assessments are developed in high-income countries, where low literacy is less of a concern. While measurement error always plagues survey data, and is

particularly pronounced for self-reported measures of socio-emotional skills such as grit (Duckworth and Yeager, 2015), these concerns are amplified for young survey respondents and respondents with low levels of literacy (Marsh, 1984). This casts doubt on the appropriateness of using self-reported student background questionnaires to measure socio-emotional skills such as grit in low literacy contexts. Measurement error resulting from response bias is of particular concern when attempting to tap socio-emotional skills through student background questionnaires. Response bias is the tendency to answer survey questions untruthfully or misleadingly. Marsh (1986) argues that there are two specific sources of response bias that plague surveys conducted with children in particular, namely reading ability and the ability of children to reflect on the content of the survey items. Duckworth and Yeager (2015: 240) summarise the psychological and psycholinguistics literature that has ensued in the decades since Marsh's work on response bias in children, and explain the process whereby students answer questionnaire items as consisting of the following steps:

“(1) Students must first read and understand the question, then (2) search their memories for relevant information, (3) integrate whatever information comes to mind into a summary judgement, (4) translate this judgement into one of the offered response items, and finally, (5) ‘edit’ their responses if motivated to do so.”

As Duckworth and Yeager (2015) argue, there are many threats to the validity of psychological constructs derived from such self-reported measures at each step in this process. Literacy is an obvious concern for the first step, while limitations in the ability to make judgements across time plagues steps (2) and (3). In addition, reference bias – the fact that participants must employ a frame of reference when responding, but that these frames of reference differ systematically across participants – is a major concern for step (3). One obvious frame of reference is students' peers, and the response bias that results from this is that students' assessment of themselves is heavily influenced by characteristics of their classmates. Reference bias is also a concern in step (4), since what one respondent considers “sometimes” might be considered “often” by another. There is also the possibility that respondents are simply faking – that is, making up answers. While there are alternatives to self-reported measures of socio-emotional skills (such as performance tasks), these measures suffer from their own catalogue of threats to validity. Measurement experts thus argue that

“... validity is not an inherent feature of a measure itself but rather a characteristic of a measure with respect to a particular end use. Thus, different measures, with their unique advantages and limitations, are differentially valid depending not only on their psychometric properties but also on their intended application” (Duckworth and Yeager, 2015: 243).

In light of the above, it is instructive to assess the reliability with which grit is measured before proceeding with an analysis of the relationship between this construct and reading performance. I argue that the biggest threat to construct validity among the sample of students used in this study is low literacy, and I therefore test for evidence that differential levels of literacy might be driving differential responses to the grit questionnaire items. Since reading scores increase with school functionality, I calculate the scale reliability coefficients of the grit scale and its subscales by school functionality tercile (Table 3) as a test for possible effects of reading ability on responses to the grit questionnaire. This also allows me to test for the possibility that differences in scale reliability by school functionality drive any observed differences in the association between grit and achievement by school functionality. Table 3 shows that at 0.43, 0.46 and 0.47, the alpha coefficients of the full grit scale are not high enough for the scale to be considered internally reliable for any of the school terciles. The alpha coefficients of the two subscales of grit indicate that low internal reliability of the ‘consistency of interest’ subscale is driving the low alpha values for the full grit scale. Removing the ‘consistency of interest’ items from the grit scale, that is,

limiting the scale to only the ‘perseverance of effort’ subscale, increases the alpha coefficients across all terciles of school functionality.

Table 3: Scale reliability coefficients for the grit scale by school functionality tercile

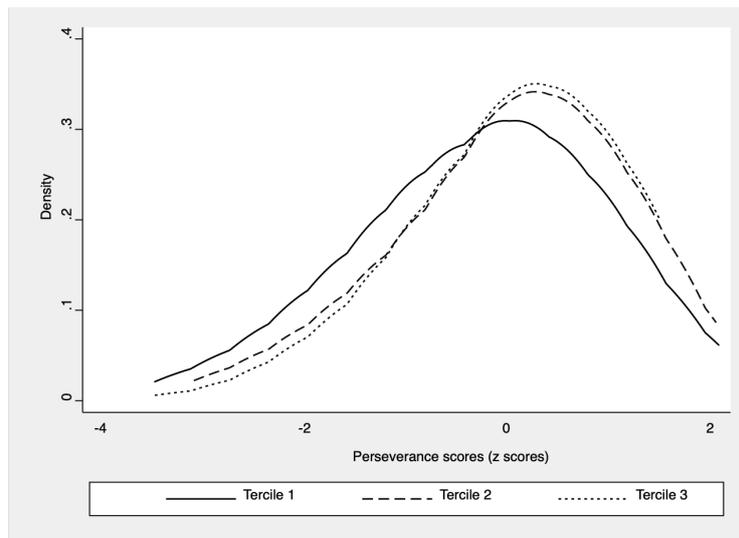
	Alpha coefficients		
	Full grit scale	‘Perseverance of effort’ subscale	‘Consistency of interest’ subscale
Tercile 1	0.43	0.54	0.22
Tercile 2	0.46	0.55	0.32
Tercile 3	0.47	0.52	0.40

The results in Table 3 do not provide any evidence of differences in the scale reliability of grit and its two subscales by school functionality. The results in the table do indicate, however, that the grit scale is not measured with sufficient internal reliability among the Leadership for Literacy sample. Although the alpha coefficients of the ‘perseverance of effort’ subscale are considered “poor” (Kline, 2000), other studies of the association between grit and academic achievement that find equally low alpha coefficients for the perseverance subscale have been accepted in the educational psychology literature. Importantly, Duckworth and Quinn (2009: 174) calculate an alpha coefficient of 0.60 for the perseverance items among a sample of US cadets (mean age 19.05), and still recommend that “the Grit-S is an economical measure of perseverance and passion for long-term goals”. For this reason, a decision was made to use only the perseverance subscale of grit in the analysis that follows.

5. Multivariate estimation results

The main objective of the multivariate estimation strategy is to determine whether the association between perseverance and reading scores differs by school functionality. Before examining the relationship between perseverance and reading scores in a multivariate context, however, it is instructive to investigate whether there are differences in the overall levels of perseverance by school functionality. To this end, the distributions of perseverance scores for each school tercile are shown in Figure 2. The figure shows that perseverance scores increase slightly with school functionality. However, it is interesting to note that the differences in perseverance scores by school tercile are much smaller than the differences in reading comprehension scores between school terciles (shown in Figure 1 above). The fact that there are minor differences in perseverance scores between school terciles but large differences in reading scores between terciles constitutes some evidence of a stronger association between perseverance and reading scores in more functional schools. I investigate this hypothesis further in a multivariate context by running separate ordinary least squares regressions for each tercile of school functionality. In addition to student SES, the following controls are included in the multivariate regressions: gender, age, the frequency of English use at home, whether the student lives with their mother and father, whether the student’s parents are employed, the language of learning and teaching (LOLT) of the school in the foundation phase, and province.

Figure 2: Kernel density distributions of perseverance scores by school functionality tercile



The results from this estimation are presented in Table 4. The results in the table indicate a large and significant association between perseverance and reading comprehension scores within all terciles of school functionality, even when controlling for a host of factors at the individual, home, and school level. Importantly, the results presented in Table 4 indicate that the size of the association between perseverance and reading scores increases with school functionality tercile, such that a standard deviation increase in perseverance scores is associated with a quarter of a standard deviation (24.8 percent) increase in reading scores among students in tercile 1 schools, compared to 35.6 percent and 36.4 percent of a standard deviation increases among students in tercile 2 and 3 schools, respectively. This provides some evidence in support of the “Matthew effect” hypothesis put forward in Section 2.2, namely that perseverance is a stronger predictor of achievement among students who already have the advantage of being in more functional schools.

The regression results reported in Table 4 further point to a large gender gap in favour of girls in terms of reading scores among the Leadership for Literacy sample. This gender gap in academic performance is well-documented in the local as well as international literature (Steinmayr and Spinath, 2008; Spaul and Makaluza, 2019), especially in reading in the primary school grades. It is interesting to note that a gender gap remains even after controlling for perseverance, as a number of authors present evidence that gender differences in socio-emotional skills may contribute to the pro-girl advantage in achievement that is documented in many countries (see for example Steinmayr and Spinath, 2008; Dercon and Singh, 2013; Spinath, Eckert and Steinmayr, 2014). The fact that the gender gap in favour of girls remains after controlling for perseverance indicates that gender differences in perseverance, at least, do not explain away the pro-girl advantage in terms of reading scores among the Leadership for Literacy sample of students. Other covariates that are significantly associated with reading scores across school terciles include being overage, having attended Grade R, and being from a wealthier home.

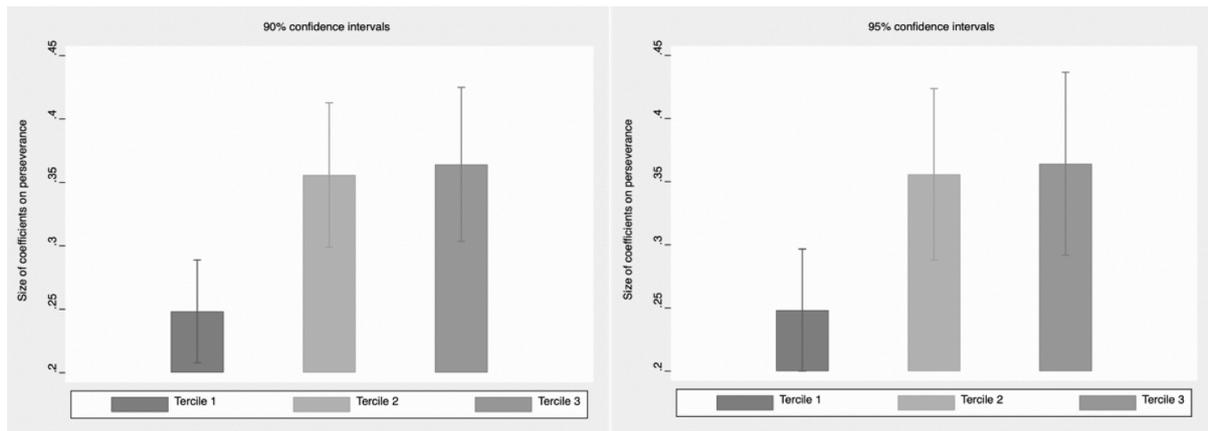
Table 4: Multivariate regression results

	Tercile 1	Tercile 2	Tercile 3
Perseverance (z-scores)	0.248** (0.037)	0.356** (0.026)	0.364** (0.048)
Female	0.314** (0.060)	0.212** (0.061)	0.284** (0.082)
Overage	-0.190** (0.052)	-0.314** (0.064)	-0.336** (0.076)
Frequency of English use at home	0.114* (0.063)	0.244** (0.078)	0.101 (0.075)
Attended Grade R	0.166* (0.067)	0.111 (0.146)	0.327** (0.117)
Asset index (z-scores)	0.178** (0.041)	0.17** (0.059)	0.200** (0.052)
Asset index ²	0.053 (0.032)	0.032 (0.048)	0.017 (0.056)
Lives with mother	0.089* (0.039)	0.092 (0.084)	-0.027 (0.074)
Lives with father	0.046 (0.076)	0.039 (0.091)	-0.103 (0.062)
At least one parent employed	0.227** (0.045)	0.022 (0.104)	-0.019 (0.086)
School functionality index	0.222 (0.124)	-0.004 (0.157)	0.051 (0.167)
School uses English as the LOLT in the foundation phase	-0.072 (0.115)	0.074 (0.089)	0.068 (0.095)
Peer SES	0.020 (0.053)	0.029 (0.097)	0.356* (0.142)
Constant	-0.929** (0.168)	-1.271** (0.245)	-1.507** (0.317)
R^2	0.32	0.28	0.27
N	868	743	772

Notes: * $p < 0.05$; ** $p < 0.01$. Standard errors (clustered at the school level) are reported in brackets. ‘Overage’ indicates that the student is one or more years older than they should be in Grade 6 (12 years). ‘Frequency of English use at home’ is a categorical variable coded as follows: 0 “Never or almost never”; 1 “Sometimes”; 2 “Always or almost always”. Province controls are included but not reported here.

To test whether the differences in the strength of the association between perseverance and reading scores by school functionality are statistically significant, I plot the coefficients on perseverance reported in Table 4 with 90% and 95% confidence intervals, respectively, around these estimates (Figure 3). The figure shows the coefficient on perseverance in tercile 1 schools is statistically significantly different from the coefficient on perseverance in tercile 3 schools at the 90 percent level, but not at the 95 percent level. This provides some evidence that perseverance may be a stronger predictor of reading scores in more functional schools.

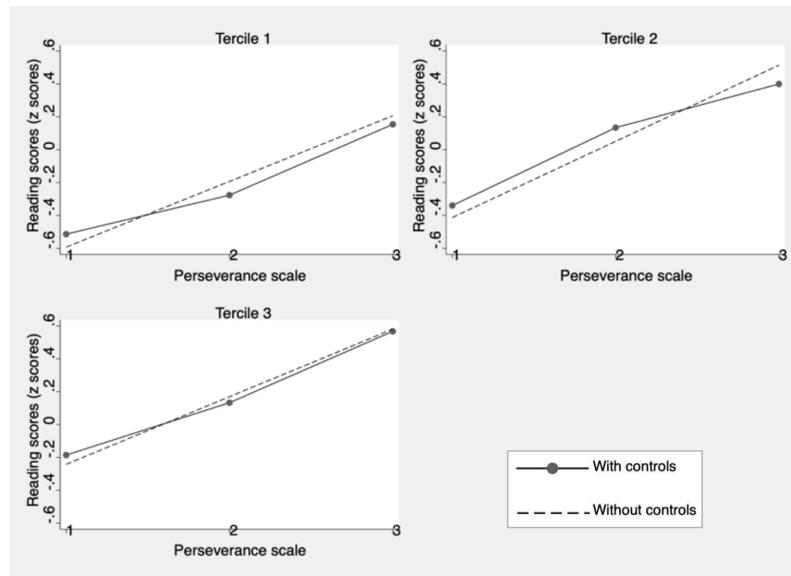
Figure 3: Size of coefficients on perseverance by school functionality tercile



To explore potential differences in the association between perseverance and reading scores further, I plot the marginal associations between perseverance and reading scores for the three terciles of school functionality (Figure 4). The dotted lines in each of the plots represent the association between perseverance and reading scores in the absence of controls. The figure points to two interesting results. Firstly, adding controls only slightly changes the association between perseverance and reading scores. Secondly, the figure shows how the relationship between perseverance and reading scores increases with school functionality, and that students with the same perseverance scores have higher reading scores when they are in more functional schools. For example, when controlling for the full set of covariates, students in tercile 1 schools who scored “low” on perseverance (a score of 1 on the scale)⁹ had reading scores almost 60 percent of a standard deviation below the mean reading score for the full Leadership for Literacy sample, while students low on perseverance in tercile 2 and 3 schools had average reading scores of around 40 and 60 percent of a standard deviation below the mean, respectively. Similarly, students high in perseverance (a score of 3 on the scale) in tercile 1 schools had reading scores just above the sample mean when controlling for the set of covariates, while their counterparts in tercile 2 and 3 schools achieved reading scores of around 30 and 60 percent of a standard deviation above the sample mean, on average.

⁹ Students were scored according to their agreement with the four items intended to tap the ‘perseverance of effort’ dimension of the short grit scale. Students who scored **high** on perseverance achieved scores of 15 or higher on the perseverance subscale, which corresponds with selecting the option “That’s a lot like me” on three of the items and “That’s sometimes like me” on one item, on average. There are 852 students who scored high on perseverance, that is, 36 percent of the sample. Students who scored **low** on perseverance achieved scores of no more than 12 on the perseverance scale, which corresponds with selecting the option “That’s sometimes like me” on all four of the items, on average. Students with low perseverance constitute a further 36 percent of the sample. All other students (the remaining 28 percent of the sample) scored **medium** on perseverance.

Figure 4: Association between perseverance and reading scores by school tercile, with and without controls

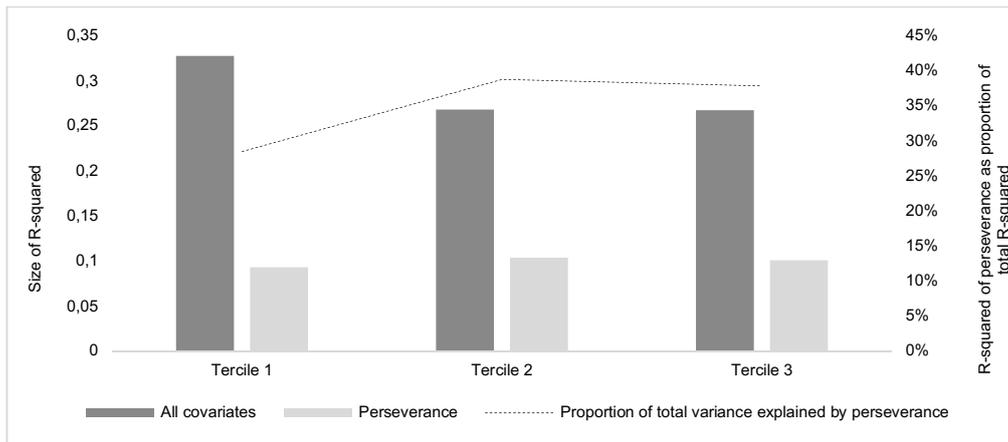


Notes: Perseverance scores are plotted as raw scores on the perseverance scale, while standardised perseverance scores are used in the regressions reported in Table 4.

I further test for variation in the association between perseverance and reading scores by school functionality by examining the proportion of variance explained (R^2) by the full set of covariates and perseverance, respectively, by school tercile. The R^2 -squared values for each of the regressions reported in Table 4 are plotted in Figure 5, along with the proportion of variance explained by perseverance alone. Two important results emerge from the figure: Firstly, the figure shows that the full set of covariates (including perseverance) explains the most variance in reading scores in tercile 1 schools (the dark grey bars). This constitutes a noteworthy result since it points to variation in the factors that matter for student achievement in different school contexts, even within a sample of schools that has largely been treated as homogenous in the South African economics of education literature. Secondly, the figure shows that perseverance explains a larger proportion of total variance in tercile 2 and 3 schools¹⁰ (the dotted line in the figure). In other words, although the differences in the size of the coefficient on perseverance between school terciles are only statistically significant at the 90 percent level, the proportion of variance explained by perseverance increases with school functionality, suggesting that perseverance is a more important predictor of reading performance in more functional schools. This result provides further evidence in support of the Matthew effect hypothesis, that is, that school functionality augments the benefits of existing socio-emotional skills for learning.

¹⁰ The R^2 on perseverance was obtained by calculating the change in R^2 when perseverance is excluded from each model.

Figure 5: Proportion of variance in reading scores explained by perseverance across school terciles



Lastly, I test for variation in the strength of the association between perseverance and reading scores by school functionality by running the regressions reported in Table 4 on the full Leadership for Literacy sample, with interaction effects between perseverance and school functionality. The results of this regression are reported in Table 5. The same factors are controlled for as in the regressions in Table 4 but are not reported. The results in the table provide further evidence of variation in the strength of the association between perseverance and reading scores by school functionality tercile: In tercile 1 schools, students high in perseverance had reading scores 66.0 percent of a standard deviation higher than students low in perseverance, on average. Students high in perseverance in tercile 2 and 3 schools, on the other hand, achieved reading scores 83.9 and 88.7 percent of a standard deviation higher than students low in perseverance in tercile 1 schools, on average. In other words, compared to students low in perseverance in tercile 1 schools, students high in perseverance in tercile 2 and 3 schools have a greater advantage in terms of reading scores than their counterparts in tercile 1 schools who are also high in perseverance. Wald tests of significance show that these differences are statistically significant at the 95 percent level.

Table 5: Interaction effects between perseverance and school functionality

	Low perseverance	Medium perseverance	High perseverance
Tercile 1	Omitted	0.204** (0.058)	0.660** (0.103)
Tercile 2	0.080 (0.106)	0.567** (0.112)	0.839** (0.123)
Tercile 3	0.147 (0.146)	0.465** (0.133)	0.887** (0.131)

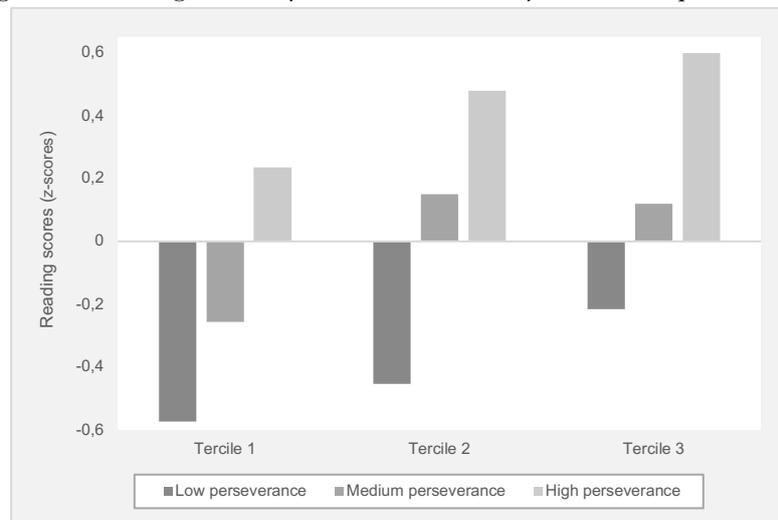
Notes: * $p < 0.05$; ** $p < 0.01$. Standard errors (clustered at the school level) are reported in brackets. The model includes the following controls: Gender, age, frequency of English use at home, whether the student attended Grade R, student SES, whether the student lives with either biological parent, whether the student has at least one employed parent, the school's LOLT in the foundation phase, peer SES, and province.

6. Functionality or literacy levels?

The multivariate regression results presented here provide some evidence of a Matthew effect in the association between perseverance and reading scores, whereby students in more functional schools benefit more from being perseverant than students in less functional schools. In this sense, the results from the multivariate regressions suggest school functionality augments the potential of perseverance to support the acquisition of reading skills. There is an alternative explanation for the results from the multivariate regressions, however, namely that differences in literacy levels between students in the

different school terciles are driving the differences in the association between perseverance and reading scores by school functionality. That is, given that average reading performance is confounded with school functionality, differences in literacy levels between low and high functionality schools may be driving the observed differences in the association between perseverance and reading scores by school functionality. Figure 6 shows the reading scores (reported as z-scores) by school functionality tercile and perseverance. The figure shows that in tercile 1 schools, different levels of perseverance are driving differences in reading z-scores between -0.6 and 0.2, whereas differences in perseverance are driving reading score differences between -0.2 and 0.6 in tercile 3 schools. It could therefore be that the observed differences in the association between perseverance and reading scores reported in Table 4 are due to perseverance being a stronger predictor of reading scores at higher levels of literacy, and not moderating effects of school functionality on the association between perseverance and reading scores.

Figure 6: Reading scores by school functionality tercile and perseverance



To investigate this possibility further, I run quantile regressions at the 25th, 50th, and 75th percentiles for each of the school functionality terciles. The coefficients on perseverance from these regressions are reported in Table 6. As is the case for the results reported in Table 5, the quantile regressions include the same controls as the regressions reported in Table 4 but are not reported. The results in the table provide some evidence that the association between perseverance and reading scores differs by literacy level, even within the same school terciles. For example, perseverance is associated with an 11.3 percent of a standard deviation increase in reading scores for students at the 25th percentile of performance in tercile 1, and a 27.1 percent increase in reading scores for students at the 75th percentile of performance in the same tercile. The same pattern is observable for students in terciles 2 and 3. Comparing the coefficients on perseverance for students who achieved roughly the same reading scores, in different school terciles, however, suggests that differences in the association between perseverance and reading scores by school functionality remain, even for students at similar levels of literacy. For example, students at the 75th percentile in tercile 1 schools achieved roughly the same reading scores as students at the 50th percentile in tercile 3 schools. However, a one-standard-deviation increase in perseverance scores is associated with 35.0 percent of a standard deviation increase in reading scores for the students in tercile 3, compared to 27.1 percent of a standard deviation increase for students in tercile 1. This result suggests that although some of the results discussed in Section 5 may be driven by differences in average reading performance across school terciles that affect scores on the perseverance scale, the observed differences in the association between perseverance and reading scores cannot be entirely explained by differences in average literacy levels across school terciles. In other words, the results in

Table 6 constitute evidence of moderating effects of school functionality on the association between perseverance and reading scores.

Table 6: Quantile regression results by school functionality tercile

	Tercile 1		Tercile 2		Tercile 3	
	Reading score	Coefficient on perseverance	Reading score	Coefficient on perseverance	Reading score	Coefficient on perseverance
25th percentile	-0.856	0.113** (0.021)	-0.657	0.224** (0.032)	-0.557	0.203** (0.041)
50th percentile	-0.507	0.164** (0.026)	-0.159	0.280** (0.038)	-0.059	0.350** (0.041)
75th percentile	0.040	0.271** (0.04)	0.638	0.434** (0.059)	0.937	0.420** (0.058)

Notes: * $p < 0.05$; ** $p < 0.01$. Standard errors (clustered at the school level) are reported in brackets. The models include the following controls: Gender, age, frequency of English use at home, whether the student attended Grade R, student SES, whether the student lives with either biological parent, whether the student has at least one employed parent, the school's LOLT in the foundation phase, peer SES, and province.

7. Discussion

The results presented here constitute evidence in support of a Matthew effect in the association between socio-emotional skills and academic achievement for students in South African township and rural schools with different levels of functionality, whereby students who are already relatively advantaged due to attending more functional school benefit more from being perseverant than their counterparts in less functional schools. It is important to note, however, that perseverance emerges as a strong predictor of reading achievement across *all* terciles of school functionality. That is, although there is evidence of variation in the association between perseverance and reading achievement by school functionality, there is nonetheless a strong association between perseverance and reading scores *even in schools with low levels of functionality*. These results make an important contribution to debates around the importance of socio-emotional skills in high-poverty contexts, since they suggest perseverance is positively associated with student achievement even in high-poverty schools, but that the size of this positive association increases with school functionality.

The strong association between perseverance and reading achievement found in this paper provides support for the notion that efforts to improve students' socio-emotional skills may be a promising way to improve students' academic success. By implication, as West *et al.* (2016: 166) argue,

“To the extent that [socio-emotional] skills prove to be malleable in school settings, interventions that target them may yield improvements in academic outcomes in addition to any long-term benefits that could accrue if school-induced changes in non-cognitive skills persist into adulthood.”

The results presented here further point to the importance of developing measures of socio-emotional skills that can be reliably used in low-literacy contexts. This recommendation follows from the finding of low reliability with which grit is measured among the Leadership for Literacy sample. Findings from the psycholinguistics literature suggest the low internal reliability of the ‘consistency of interest’ subscale of grit may be due to the fact that the items comprising the scale are negatively worded. Negatively worded items are typically included in questionnaires to guard against acquiescence bias, where respondents tend to agree with statements without regard for their actual content (Salazar, 2015). However, the results presented in this paper add support to growing consensus in the psycholinguistics literature that attempting to correct for acquiescence bias by including negatively worded items introduces artefacts that may be more problematic for construct validity than acquiescence bias (Weems

et al., 2003; Weems, Onwuegbuzie and Lustig, 2009; Roszkowski and Soven, 2010; Salazar, 2015). I therefore echo the recommendation from this literature to not include negatively worded items in educational assessments, especially when student background questionnaires are administered in contexts of low literacy. At the very least, the results presented here show that the wording of questionnaire items is extremely important in determining the reliability with which socio-emotional skills are measured and therefore requires careful consideration. Teacher-reported measures of student socio-emotional skills are likely to circumvent these issues altogether; however, teacher reports are subject to a different set of measurement problems that do not plague self-reported measures of socio-emotional skills. For this reason, I echo Duckworth and Yeager's (2015) recommendation of using a plurality of measurement approaches (including orally administered self-reports and teacher reports) for the measurement of socio-emotional skills in low literacy contexts.

The results presented in this paper are subject to a number of important limitations. Firstly, and perhaps most pressing, is a limitation that plagues all models of student achievement that make use of cross-sectional data, namely that causality cannot be inferred from the correlations between perseverance and reading achievement reported here. Studies that attempt to overcome this limitation usually employ early measures of socio-emotional skills to predict later outcomes (Almlund *et al.*, 2011). Only when such data becomes available will it be possible to attempt to infer causality in the relationship between socio-emotional skills and academic achievement for South African children. It is important to note, however, that results from the existing studies that make use of multiple measures of socio-emotional skills across time suggest a causal relationship between the Big Five traits of Conscientiousness, which overlaps significantly with perseverance¹¹ and academic achievement (Almlund *et al.*, 2011).

Secondly, the measure of perseverance used in this study likely suffers from significant measurement error. Although the scale reliability coefficients of the perseverance scale are high enough to be considered acceptable, a four-item scale will inevitably be limited in its ability to capture the “true” construct of perseverance. Similarly, the outcome variable of interest used in the analysis, namely scores on a silent comprehension test administered in English, also has limitations as a measure of reading ability, especially since English was a second language for almost all students in the sample (although all of them have been taught in English since at least Grade 4).

Lastly, the samples of schools in the different functionality terciles are relatively small, and were not sampled to be either provincially or nationally representative. Therefore, while the results presented in this paper constitute an important first step towards understanding the relationship between socio-emotional skills and learning outcomes in the South African context, more evidence from different samples of students is required to deepen our understanding of this relationship. In addition, as Duckworth and Yeager (2015: 246) argue, “too little is known about the question of how to *act on* data regarding the personal qualities of students in various classrooms or schools” (my emphasis). That is, while we know that socio-emotional skills matter for children’s academic outcomes, we still know very little about how to improve these skills, especially in low- and middle-income countries. Evidence from the United States suggests parental investment, education, and interventions can meaningfully improve socio-emotional skills (Almlund *et al.*, 2011). Importantly, evidence from Heckman and others shows that socio-emotional skills are more malleable at younger ages, and that early childhood investments have the largest and longest-lasting effects (Cunha and Heckman, 2008; Almlund *et al.*, 2011; Heckman and Kautz, 2012; Kautz *et al.*, 2014). This points to investments in early childhood as a potentially

¹¹ Big Five Conscientiousness is defined as “the tendency to be hardworking and persistent” by Kautz *et al.* (2014). Furthermore, Rimfeld *et al.* (2016) calculate a genetic correlation of $r = .84$ between perseverance and conscientiousness in a study of 2,321 pairs of twins.

important policy lever for improving educational outcomes in South Africa. However, local evidence of the effectiveness of such programs is required. Only once such data becomes available will it be possible to design policy interventions aimed at fostering the socio-emotional skills of South African children.

8. Conclusion

The present study makes an important contribution to the South African economics of education literature in that it is one of only a handful of local studies that evaluates the relationship between socio-emotional skills and academic achievement using large-scale assessment data. The strong positive relationship between perseverance and reading scores across all terciles of school functionality found in this study suggests further investigating this relationship in the South African context is likely to be a fruitful avenue for future research. Moreover, the evidence presented here suggests school functionality moderates the potential of socio-emotional skills to augment the acquisition of cognitive skills such as reading. This has important implications for both education policy and practice. Crucially, the evidence presented here points to the conclusion that while socio-emotional skills may be important for academic success in high-poverty contexts, focusing on the development of students' socio-emotional skills should not detract from efforts to remedy systemic failures in education systems.

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