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Illuminating shadow education in South Africa:

Mapping participation in and demand for extra lessons

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Illuminating shadow education in South Africa:

Mapping participation in and demand for extra lessons

Joy Olivier[1] and Heleen Hofmeyr[2][3]

Abstract

The term 'shadow education' is widely used in the international literature to refer to after-school tutoring programmes (Zhang and Bray, 2020: 335). This paper investigates the prevalence of after school programmes in South Africa, focusing on extra maths lessons not provided by the school. Since 1995, the TIMSS results have consistently revealed that the majority of the country's learners participate in extra lessons not provided by schools (Baker, 2001; Bray & Kobakhidze, 2014). However, there is very little research on the participation rates in this type of education in South Africa. This study analyses 2019 TIMSS data from grade 9 learner surveys, primarily focusing on participation in extra mathematics lessons. It seeks to determine demand-side factors driving shadow education in South Africa using descriptive statistics and regression analysis. We find that participation in extra mathematics lessons offered by schools is high in South Africa, and greater among learners from lower socio-economic backgrounds and school quintiles. The paper concludes with a call for further research and highlights the need for a national audit of after-school programmes.

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1. Introduction

Research on schooling in South Africa has largely been silent on shadow education. This constitutes a significant gap in our understanding of the national education system, given that shadow education is "now established as a significant subfield of educational studies" in the international literature (Zhang and Bray, 2020: 335), and moreover, that the majority of South African learners participate in it. This paper seeks to address this gap by investigating the nature of, and the factors that shape, the demand for extra lessons in South Africa. This is done using the Trends in International Mathematics and Science Study (TIMSS) data for South Africa, which collects information about whether learners attend extra mathematics or science lessons in its learner background questionnaire. This information is used to estimate the incidence of, and to investigate the nature of demand for, extra maths lessons not provided by the school.

2. Literature review

2.1. Defining shadow education

> *"Shadows can of course be useful. Just as the shadow cast by a sun-dial can tell the observer about the passage of time, so the shadow of an education system can tell the observer about change in societies"* (Bray, 1999:17).

The term 'shadow education' is widely used in the literature to refer to after-school tutoring programmes, although the meaning of the term remains the subject of lengthy debates in the literature. Given the ambiguity inherent in the term, Zhang and Bray (2020) suggest that each study on the topic should take care to clearly define what is, and is not, included under the umbrella of 'shadow education'. For the purposes of this paper we adopt Paviot, Heinsohn and Korkman's (2008: 151) simple definition of shadow education as "extra lessons in school subjects outside school hours." We adopt this simple definition since there is a dearth of evidence of the size of South Africa's shadow education sector, and we consider this paper a first step in drawing researcher and policy attention to the existence of this significant component of the country's education system. Paviot, Heinsohn and Korkman's (2008)'s simple definition is thus best suited for accomplishing our research aims.

Internationally, much work has been done to illuminate the incidence and nature of shadow education systems across the world. Beginning in the early 2000's, the first decade of this research agenda was characterised by efforts to map participation in shadow education in different countries, mostly using learner responses to questions about enrolment in extra lessons in the learner background questionnaires of large-scale international education assessments, such as the Programme for International Learner Assessment (PISA) and the TIMSS (Zhang and Bray, 2020). Most of the early research focuses on the demand for shadow education (Zhang and Bray, 2020).

2.2. Existing evidence of shadow education in South Africa

The lack of local investigation into the scale and nature of South Africa's shadow education system is something this paper seeks to address. International research into the prevalence of shadow education across countries using the TIMSS data indicates that since 1995 (the first time that the

assessment was administered in South Africa), the majority of learners have been participating in shadow education (Baker, 2001; Bray & Kobakhidze, 2014).

Zhang and Bray (2020), in a review of the existing body of evidence on shadow education worldwide, make the case that more must be done to map participation in shadow education, especially in Africa: PISA and TIMSS data has been used to map patterns in shadow education in Europe and Asia, but "obvious gaps remained in Africa" (Zhang and Bray, 2020: 327). They argue: "… a major World Bank review of education in Africa made only passing reference to shadow education, stating that 'little is known' about the matter."

A finding from cross-national studies of shadow education that has largely gone unnoticed by local researchers and policy makers alike, is that for many years, South Africa has had some of the highest participation rates in shadow education in the world. Going back as far as 1995, South Africa had the fifth-highest enrolment rate in shadow education out of 41 countries participating in TIMSS that year (at around 70%) (Baker *et al.*, 2001). Readers knowledgeable about schooling in South Africa, and the extent to which shadow education is a marginal, if not largely absent, consideration in the research and policy-making discourse, might agree with Bray and Kobakhidze (2014: 600) that this finding "seems counterintuitive to the point of deserving fundamental scrutiny." However, it is likely that such sentiments may be the result of a lack of attention to the phenomenon, rather than for example, unreliable data. While we agree with Bray and Kobakhidze (2014) that data on enrolment in shadow education should not be taken at face value, such a consistent finding is clearly worthy of further investigation.

Existing research on shadow education has focused predominantly on the supply side of extra tuition, after school programmes (ASPs), and other specific interventions provided by private and civil society actors (e.g. Spaull et al. 2012; Böhmer et al. 2014 & McLean et al. 2016). Evidence of the nature and scope of after-school tutoring programmes presented by Reddy, Lebani and Davidson (2003), for example, supports the results from TIMSS data spanning more than 20 years, that shadow education in South Africa is indeed a large sector serving many learners.

Reddy et al. (2003) set out to assess the extent, nature, and cost of out-of-school mathematics, science and computer studies programmes serving learners in grades 10 –12. The authors note the broad range of service providers, from individuals to organisations, providing both online and/or in-person tuition. Types of service providers include private sector companies (including franchises), non-governmental and community-based organisations, initiatives driven by the Department of Basic Education (DBE) in partnership with service providers, and tertiary institutions' outreach programmes. There are also unregistered service providers operating in the informal economy. The authors find that most initiatives focus on mathematics and science, and operate in urban areas, mainly in the metropolitan areas of Gauteng, KwaZulu-Natal and the Western Cape, and in rural schools in Limpopo. Extra classes also take various forms in South Africa. In their survey of grade 11s in the East London district of the Eastern Cape, Mogari, Coetzee and Maritz (2009: 36) find that supplementary tuition was popular, especially among girls, and was delivered in three different formats: "private tuition, vacation school and problem-solving classes", the latter of which they describe as "classes dominated by working on past/model examination papers."

There is, however, a dearth of recently published literature on the factors driving the proliferation of supplementary tutoring in South Africa. In their 2009 paper, Mogari et al. discuss potential factors influencing the demand for extra lessons, including the lack of qualified mathematics teachers, a bloated curriculum, and the link between performance on the National Senior Certificate (NSC) and access to post-school education and employment. This evidence suggests that the shadow education sector in South Africa may serve to fill learning gaps that are not addressed in schools themselves.

2.3. Participation in shadow education and learning outcomes

Bray (2007: 50) writes that the impact of shadow education interventions is extremely varied, and depends on a number of contextual factors, such as "the content and mode of delivery of the tutoring, the motivation of tutors and tutees, the intensity, duration and timing of tutoring and the types of pupils who receive tutoring." Reddy et al. (2003: 20) note that "the performance of… learners is largely a function of many factors, some of which fall outside of the immediate learning environment."

An interesting finding from the international research is that in most countries, participation in shadow education is negatively correlated with learner achievement (Baker *et al.*, 2001). This does not mean, however, that attending extra lessons causes learners to achieve poorer results, but rather is more reflective of who actually attends in the first place and maybe a methodological question of how the study is conducted. TIMSS was not designed to investigate the impact of extra tuition, and a major limitation of using cross-sectional data is that there are many confounding factors (including prior ability, school quality, parental involvement, socio-economic status (SES), and others) that no doubt have a much larger impact on learner achievement than the impact of attending extra lessons alone. Taylor (2019: 322), for example, explains why one cannot interpret observed associations between attending extra lessons and learner achievement in TIMSS as an approximation of the impact of those lessons:

> If one compares mathematics performance between children who attend extra mathematics lessons and those who do not (as one could using TIMSS data), it will not be clear what to make of whatever difference is observed. Those who attend extra lessons may do so precisely because they are struggling and therefore need to attend. On the other hand, those who attend may do so because their parents care about their education and can afford to pay for extra lessons, meaning that these children would do better in mathematics even aside from the extra lessons.

Due to this limitation, we do not attempt to analyse whether participation in shadow education has an impact on learner achievement. The analysis is aimed instead at presenting the kind of evidence on shadow education in South Africa that is available for most other countries participating in TIMSS, that is, the mapping and identification of demand-side factors of shadow education in the country (Van der Berg and Gustafsson, 2019).

3. Current study

Given the extent of poor-quality schooling in South Africa (Spaull and Jansen, 2019), it is crucial that we understand to what extent the shadow education sector acts as a complement to formal schooling. We are particularly interested in the extent to which this sector serves those learners who are least likely to have the formal curriculum adequately covered during school hours, that is, learners attending low- and no-fee (Quintile 1 to 3) schools[4].

The TIMSS data is particularly suited to understanding the extent to which shadow education supplements formal schooling since the question about extra lesson attendance in the student background questionnaire asks specifically whether learners had attended extra mathematics or science lessons in the past year. As is the case in many countries, particular emphasis is placed on achievement in mathematics as an indication of learners' abilities and thus as a predictor of later learning outcomes (Van Broekhuizen, Van der Berg and Hofmeyr, 2016). Performance in mathematics in grade 9 carries particular weight in South Africa as learners must decide whether they will take mathematics or mathematical literacy in grade 10. Since many schools do not allow learners who perform below a certain threshold in mathematics in grade 9 to take 'pure' mathematics in grade 10, performance in the subject at the grade 9 level is particularly important for determining learners' future educational and employment prospects. Given the high stakes that are associated with this, investigating the extent to which learners turn to shadow education to make up for learning gaps in this subject is therefore particularly instructive for understanding the extent to which shadow education serves to complement the formal schooling system in general. The analysis in this paper is therefore limited to participation in extra mathematics lessons.

4. Data description

4.1. Study design

The grade 8 TIMSS 2019 assessment was administered in 39 participating education systems from across the world. Countries that suspect that the assessment may be too difficult for their grade 8 learners can opt to test their grade 9 learners. South Africa went with this option in the 2003, 2011, 2015 and 2019 cycles of the assessment.

TIMSS makes use of a two-stage sampling design, where schools (the primary sampling units) are sampled according to province and school quintile (an implicit stratification criterion) so that the final sample is nationally representative. One grade 9 class from each school is then randomly selected for participation, making classes the second-stage sampling units. Thirty schools were sampled from seven out of South Africa's nine provinces, however, the Gauteng and Western Cape provinces were purposefully oversampled since these provinces wished to gain more detailed information about variation in mathematics and science achievement in the 2019 round of the TIMSS assessment. As a result, 150 schools were sampled in each of these provinces. We make use

[4] South Africa's public schools are assigned a "quintile" between 1 and 5. Rather than equally distributed across quintiles, schools are assigned a quintile in accordance with the income, literacy and unemployment levels in a community, with Quintile 1 being the 'poorest', and Quintile 5 the 'least poor'. Schools in quintiles 1 to 3 are 'no-fee schools', in that they do not charge school fees. Approximately 80% of all learners are accommodated in 'no-fee' schools nationally (DBE, 2020).

of sampling weights in our analysis so that this oversampling is taken into account. The sample for analysis in this study was limited to public schools[5].

The main econometric strategy employed to investigate demand-side factors associated with extra mathematics lesson participation is ordinary least squares (OLS) regression analysis. We make use of logistic OLS regressions to regress the probability of extra lesson attendance on a number of factors theoretically associated with participation. Stata's svy command is used to account for the survey design of the TIMSS data (including weighting of observations and the fact that learners are nested in classrooms, and classrooms are nested in schools).

Online investigation into the supply side of extra lessons was conducted to get a sense of the different types of providers and their locales, learner reach, fees, and programme offerings. A small, purposive sample of providers was interviewed, as well as some funders of non-profit and community-based organisations providing extra lessons. Although there is a dearth of literature on extra lessons in South Africa, there are a handful of independent studies on NGOs providing extra mathematics lessons (Bo̎hmer et al. 2014; Spaull et al. 2012; McLean et al. 2016), and interested readers can look to the grey literature published by donors and Government departments for more information about South Africa's After School Programme sector in general (for example, YASPO, 2020; YASPO 2020a & Olivier, 2021).

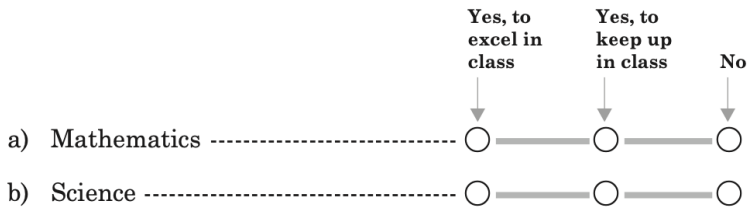
4.2. Key measures

Participation in shadow education

Participation in shadow education was measured as learner responses to the following questions in the learner background questionnaire:

A. During the last 12 months, have you attended extra lessons or tutoring not provided by the school in the following subjects?

*Fill **one** circle for each line.*



[5] According to the nationally representative TIMSS data, 4.3% of grade 9 learners are in independent schools.

B. For how many of the last 12 months have you attended extra lessons or tutoring?

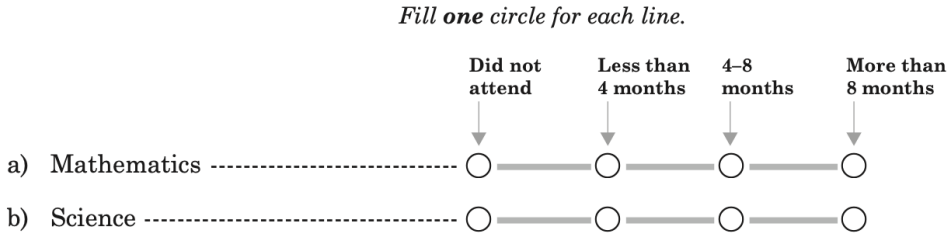


Figure 1: Items used to measure participation in extra lessons in the 2019 TIMSS student background questionnaire. Source: IEA's Trends in International Mathematics and Science Study – TIMSS 2019 Copyright © 2019 International Association for the Evaluation of Educational Achievement (IEA). Publisher: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College.

Preliminary analysis of learner responses to these questionnaire items is presented in Section 5 below. Based on this analysis, our measure of extra lesson participation is limited to participation in extra mathematics lessons in our multivariate models. We also collapsed the variable that asked about participation in extra lessons into a dummy variable that takes on a value of 1 if learners indicated that they had attended extra lessons and 0 if they did not.

Other covariates

Mathematics achievement is measured as the first plausible value[6] assigned to learners in the TIMSS assessment, based on item response theory (IRT) modelling. We also control for a number of variables available in the TIMSS data at the individual, home, and school level that we hypothesised may be associated with participation in extra lessons. At the learner level, we control for student age (coded as a dummy variable indicating whether learners are one or more years older than they should be in grade 9) since students who are overage for their grade are likely to have repeated at some point during their schooling careers and may therefore require remedial attention, such as extra lessons. We also control for the frequency with which learners spoke the language of the test at home (coded as a dummy variable indicating whether learners "always" or "almost always" spoke the test language at home), since second-language English speakers may struggle more than their first-language counterparts to keep up with an English curriculum, and may therefore seek out extra tuition.

At the household level, we control for parents' education (coded as a dummy variable indicating whether at least one parent had completed high school (matric)). We hypothesised that learners with better-educated parents would be more likely to participate in extra lessons, given evidence from the international literature that better-educated parents value education more (Boonk *et al.*, 2018). Similarly, assuming that the number of books at home also provides an indication of how much parents value education, we hypothesised that learners who have more books at home would

[6] Unfortunately, it is not possible to nest learners within classrooms and classrooms within schools using Stata's pv command. Because of this, a decision was made to only use the first plausible value. The results using the first plausible value were checked against those from using the other four plausible values, and are robust to the use of any of the five plausible values.

be more likely to attend extra lessons, and included a dummy variable indicating whether learners had more than 10 books at home. Given the costs associated with extra mathematics lessons, we also hypothesised that wealthier students would be more likely to participate in extra lessons, and therefore also control for household wealth, measured as scores on an asset index constructed using Principal Components Analysis (PCA) on nine possessions learners indicated having in their homes.

Finally, we control for a number of school characteristics that we hypothesised may be associated with extra lesson attendance of individual learners. At the classroom level, we control for teacher's age and gender to investigate whether such characteristics of teachers are associated with extra lesson attendance. We also take into account three variables that are intended to capture some of the classroom reference effects that may influence whether learners attend extra lessons, namely the proportion of the class with language difficulties (teacher-reported), the proportion of the class that is overage, and the mean TIMSS mathematics score at the classroom level. At the school level, we adjust for school wealth since we anticipate that learners in wealthier schools would be more likely to attend extra lessons. School wealth was measured as the official DBE quintile status of schools. We also expect that schools with better physical resources would be in a better position to provide extra lessons, and control for this using dummy variables that indicate whether the school has computers and a library as proxies for physical school resources. Finally, we hypothesised that learners in schools that offer extra mathematics and science lessons (principal-reported) would be more likely to attend extra lessons, and control for this variable from the school context questionnaire.

5. The prevalence of shadow education in South Africa

5.1. Participation in extra mathematics and science lessons

Responses to the two questions about extra lesson participation for the sample of 19,990 learners surveyed in South Africa are plotted in Figure 2 and Figure 3. The figures show that a large proportion of learners had missing values for both questions about extra mathematics lessons (21%). These missing values were dealt with by assigning them a value of 0, which is equivalent to responding that they did not attend extra lessons. As a result, our estimates of participation in extra mathematics lessons are likely to be an underestimate of the 'true' rates of participation in extra lessons. We further control for whether a learner had missing responses to these questions in our multivariate models of the demand for shadow education.

Overall, 61% of sampled learners indicate that they attended extra mathematics classes not provided by the school. According to the TIMSS data, the estimated population size of all grade 9 learners in South Africa is 832,026 learners. This means there were roughly half a million (507,535) grade 9 learners attending extra mathematics lessons in 2019. It should be noted, however, that although these enrolment numbers are high, only 15% of the TIMSS sample indicated that they had attended extra mathematics lessons for longer than 8 months (Figure 3). It therefore appears that while a substantial number of grade 9 learners attend extra mathematics lessons in South Africa, the duration of participation appears to be short. Further research is needed to investigate the reasons behind this, i.e. whether extra lessons are used for accelerated learning or catch-up within a short time-frame, or if learners stop attending due to responsibilities at home, enrollment in other ASPs not providing mathematics lessons, programme quality, availability, or cost issues.

Figure 2: Responses to question about attending mathematics extra lessons, full TIMSS sample

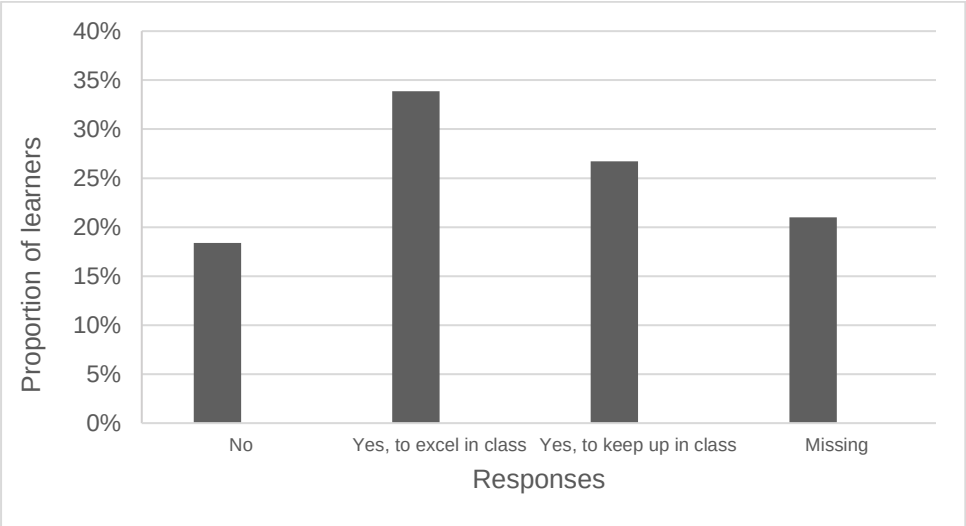
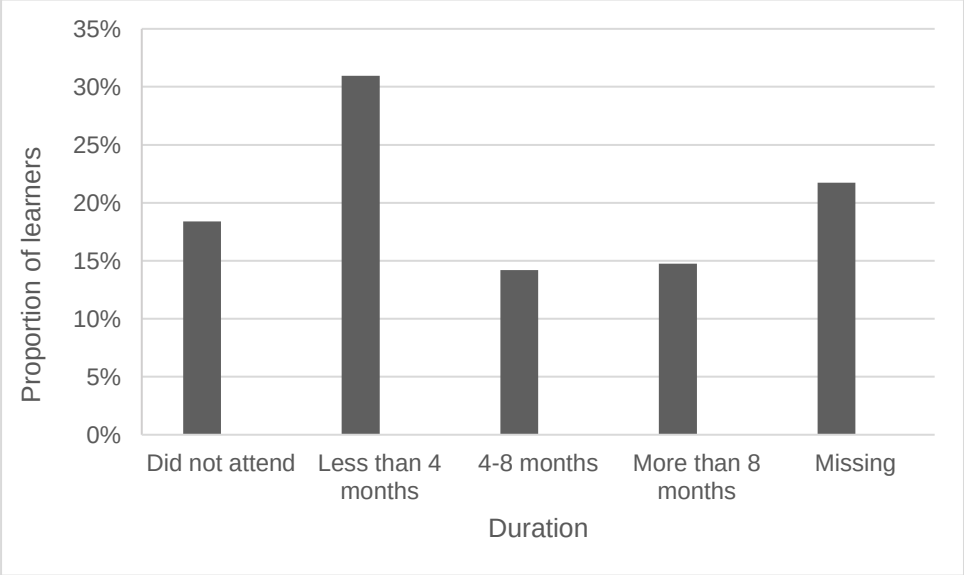


Figure 3: Responses to question about duration of extra mathematics lesson attendance, full weighted TIMSS sample



5.2. TIMSS achievement of learners attending extra lessons

Do learners attend for enrichment or remedial purposes?

Table 1 shows the frequencies of learners who indicated they attend extra mathematics lessons "to excel in class" versus "to keep up in class". The proportions reported are only among students who indicated that they attended extra mathematics lessons. The results in the table show that just over half (56%) of learners who attended extra lessons indicated doing so "to excel". It is important to note, however, that the mean mathematics scores of both these groups was still below the TIMSS low international benchmark of 400 points – in fact, more than half (55%) of learners who indicated they attend extra mathematics lessons "to excel" did not reach this benchmark, indicating that they were perhaps responding with a perceived more socially desirable answer, or that they are overestimating their performance in mathematics.

Table 1: Comparison of different reasons for attending extra mathematics lessons

	Frequency	Proportion
To excel in class	6,747	56%
To keep up in class	5,314	44%

Notes: Proportions expressed as proportions of all learners attending extra mathematics lessons. Source: TIMSS (2019).

5.3. Characteristics of learners attending extra lessons

Having considered the overall prevalence of shadow education in South Africa , it is instructive to consider differences in the characteristics of learners who attended extra lessons. Differences in the proportions of learners attending extra mathematics lessons along a number of individual-level dimensions are reported in Table 2. The results in the table indicate that girls, learners with at least one parent who has obtained matric, and learners who reported having at least 10 books in their homes are all more likely to attend extra mathematics lessons. By contrast, learners who indicated "always" or "almost always" speaking the language of the test at home were *less* likely to attend extra lessons, as were learners in the top 20% in terms of household wealth (measured as scores on the asset index described in Section 3). These results are explored further in the multivariate regression analysis.

Table 2: Percentages of learners with certain characteristics attending extra lessons compared to those not attending extra lessons

	Not attending	Attending
Female	59.7%**	61.5%
Overage	60.9%	60.1%
Always or almost always speaks test language at home	64.3%***	54.0%
Wealthiest 20%	61.0%*	59.2%
Parent has matric	56.8%***	62.5%
More than 10 books at home	57.22%***	63.4%

Notes: Statistically significant differences are indicated by asterisks such that *** p<0.01; ** p<0.05; * p<0.1.

Table 3 presents the interesting result that enrolment rates in extra lessons are higher among learners in Quintile 1-3 schools (between 63% and 66%) than in Quintile 4 and 5 schools (57% and 50%, respectively). Standard errors around these mean participation rates are also provided in the table, and show that these differences in participation rates between Quintile 1-3 schools on the one hand, and Quintile 4-5 schools, on the other, are statistically significant. From our interviews with ASP providers and funders[7], it appears that that ASP provision is likely through a variety of actors, including civil society efforts supported by donor funding, tertiary institutions, government

[7] Informal interviews were held with ASP implementers either currently or previously funded by The Learning Trust, and with donors participating in research on ASP funding supported by the Independent Philanthropy Association of South Africa (IPASA) and The Learning Trust (forthcoming).

departments, small medium and micro enterprises (SMMEs) and informal providers providing low-cost or volunteered services.

Table 3: Enrolment rates in extra mathematics lessons, by school quintile

Quintile	Proportion enrolled	Standard error
1	65%	0.82
2	66%	0.77
3	63%	0.66
4	57%	0.79
5	50%	0.84

Source: TIMSS 2019

We were particularly interested in understanding the demand from learners attending no-fee schools. To investigate the demand from learners attending no-fee versus fee-charging schools, the proportions of learners attending extra lessons from these two types of schools are reported in Table 4, for the Western Cape, Gauteng and the other provinces combined (they cannot be separated out due to sample sizes). The table shows that enrolment in extra mathematics lessons was significantly higher among learners in no-fee schools relative to fee-charging schools. It is also interesting to note that although overall enrolment in extra mathematics lessons is comparatively low in the Western Cape, extra lesson attendance was also statistically higher among learners in no-fee versus fee-charging schools in that province (53% versus 44%). Together, this evidence points to the existence of a large, low- and/or fee-free ASP sector that acts as a complement to formal schooling in South Africa, particularly for learners in the no-fee part of the schooling system.

Table 4: Proportions of learners enrolled in extra mathematics lessons, by province and fee-paying status of the school

Province	No-fee	Fee-paying
Gauteng	0.69***	0.61
Western Cape	0.53***	0.44
Other provinces	0.64***	0.57

Notes: Statistically significant differences are indicated by asterisks such that *** p<0.01; ** p<0.05; * p<0.1.

6. Factors shaping the demand for shadow education in South Africa

We now turn to the presentation of the results from our multivariate analysis, where we model participation in extra mathematics lessons as a function of a number of variables at the individual, home and school level. We make use of logistic regressions, where the outcome variable of interest is a dummy variable that takes on a value of 1 for learners who had attended extra mathematics lessons and 0 for learners who had not. Coefficients are presented as odds ratios, where values smaller than 1 indicate a lower probability of attending extra lessons, and values greater than 1

indicate a greater probability of attending extra lessons. The results of our main models are reported in Table 5.

The results in Table 5 point to a number of interesting results regarding the factors that predict participation in extra mathematics lessons. In terms of individual-level characteristics, girls are significantly more likely to attend extra mathematics lessons in Gauteng, but not in the rest of the provinces. The frequency with which the test language is spoken at home is associated with a lower probability of participation in extra mathematics lessons among learners in Gauteng and the Western Cape, an effect which is also absent among the rest of the provinces.

All three home-level variables controlled for significantly predict the probability of participation in extra lessons in the Western Cape and the rest of the country. The only exception to this is parents' education among the Gauteng sample, which does not emerge as significant in a multivariate context. This suggests that once controlling for the school's fee status, learners who come from better-resourced homes – perhaps indicating that their parents are more able to invest in their education – are more likely to attend extra mathematics lessons.

In terms of classroom-level variables, it is interesting to note that the class mean TIMSS mathematics score is negatively associated with the probability of a learner attending extra mathematics lessons in Gauteng, while this variable is positively associated with the probability of attending extra mathematics lessons in the rest of the country. In terms of school characteristics, learners in fee-paying schools are significantly less likely to attend extra mathematics lessons than their peers in no-fee schools, except in Gauteng.

Table 5: Results of predicting the probability of attending extra mathematics lessons

	Gauteng	Western Cape	Other provinces
Individual level:			
Female	1.168**	1.131	1.042
	(0.073)	(0.071)	(0.052)
Overage	1.010	0.931	1.010
	(0.064)	(0.086)	(0.061)
Speak language of test at home	0.822***	0.569***	0.957
	(0.056)	(0.056)	(0.070)
Home level:			
Asset index (z-scores)	1.177***	1.120***	1.174***
	(0.046)	(0.044)	(0.029)
Parent education	1.148	1.157**	1.165***

	(0.085)	(0.068)	(0.063)
At least 10 books at home	1.323***	1.398***	1.400***
	(0.091)	(0.087)	(0.073)
Classroom level:			
Teacher is female	1.060	0.856	0.859
	(0.106)	(0.086)	(0.068)
Teacher's age	1.034	0.987	1.072
	(0.038)	(0.038)	(0.043)
% of class with Language difficulties	1.181	0.897	1.404***
	(0.121)	(0.119)	(0.147)
% of class that is overage	0.889	1.260	1.068
	(0.133)	(0.238)	(0.140)
Class mean mathematics score in TIMSS (z-scores)	0.737***	1.224**	1.378***
	(0.056)	(0.104)	(0.126)
School level:			
School has computers	1.001	1.001	1.008**
	(0.001)	(0.001)	(0.003)
Library	1.007	1.085	0.801
	(0.118)	(0.138)	(0.104)
School offers extra lessons	1.268	0.837	1.624***
	(0.212)	(0.181) ***	(0.270)
Fee paying	0.813	0.664***	0.532***
	(0.125)	(0.102)	(0.081)
N	5,222	5,197	9,470

Notes: Source: TIMSS 2019. Statistical significance indicated by asterisks such that *** $p<0.01$; ** $p<0.05$; * $p<0.01$. Coefficients presented as odds ratios. Standard errors reported in parentheses.

7. Discussion

7.1. Summary of main results

There is a large ASP sector serving the most economically disadvantaged learners across South Africa. Participation in extra mathematics classes is high across the TIMSS grade 9 sample (61%), and more so among learners in Quintile 1-3 schools (between 63% and 66%) than learners in Quintile 5 schools (50%). It is important to note, however, that the duration of extra mathematics lesson attendance appears to be short, with only 15% of the sample of grade 9 learners indicating that they had attended for longer than 8 months. This result should be interrogated in future research, as it suggests perhaps extra lessons are used for accelerated learning or catch-up within a short time-frame.

As is the case internationally (Bray & Kwo, 2013), it appears that extra lessons in South Africa are for remedial purposes, and serve to fill the learning gaps that are not addressed in school, as extra lesson participation rates are significantly higher in poorer (Quintile 1-3) schools than in wealthier (Quintile 4-5) schools. This finding suggests that learners in the poor-performing part of South Africa's schooling system look to extra mathematics lessons to make up for poor quality instruction during the normal school day. Again the short duration of extra lesson attendance should be kept in mind. The result that extra lesson attendance is more common among learners in no-fee schools, but that learners seldom attend for longer than two months, could suggest that learners in poor-quality schools attend extra mathematics lessons for short bursts of time, perhaps as an exam preparation strategy. More research is needed to better understand the nature of extra lesson attendance, including what factors make learners attend for only short periods of time.

7.2. Limitations

The most serious limitation to the results presented here is the nature of the data regarding participation in extra mathematics lessons. Variables constructed from student responses are fraught with a number of challenges, perhaps most pressing of which is the risk of response bias (Duckworth and Yeager, 2015). Of particular concern is the possibility of acquiescence bias, whereby respondents provide answers that they think will be agreeable to assessors. The risk of this is especially pronounced among young respondents, who may feel pressure to provide the "correct" answers to adult assessors. Unfortunately, given the limited information about after-school programme attendance captured in the TIMSS data, it is not possible to control for such response bias. The results presented in this paper should therefore be interpreted with this limitation in mind.

This limitation of the TIMSS data also speaks to the importance of collecting reliable data on after-school participation in South Africa, through for example detailed attendance records by after-school programme providers. Only once such data becomes available will it be possible to determine the nature of participation in after-school programmes in South Africa with more accuracy. It should be noted however that 89% of school principals in no-fee schools reported that their schools offered extra lessons. This provides some assurance that there is a high prevalence of extra lessons, and points to the need for an audit of providers.

7.3. Implications for education research and practice

Bray lamented in 1999 that few education planners and policy-makers have adequate data on supplementary tutoring and its implications for education systems and social change. This is still the case today in South Africa; something this paper hopes to help address. TIMSS results since the mid 1990s have shown the wide prevalence of supplementary classes, and yet very little is known about the sector. Extra tuition seldom enters discussions around education in South Africa and, to our knowledge, there is only one published paper that investigates the local after-school programming sector at large (Reddy, Lebani and Davidson, 2003). The results from the analysis presented here clearly show that extra mathematics lessons are a widespread phenomenon in South Africa's education ecosystem. It is clear that many learners attend extra lessons, and that most do for a relatively short time (less than 8 months).

More needs to be done to understand the nature of these extra lessons, and the findings in this study spark more questions than answers: Who is providing, paying for and delivering these extra lessons? When and where are they held? What are enrollment rates for other grades and other subjects? How are they structured and what pedagogical approaches are employed? What educational resources and/ or materials are used? Why are learners generally attending for less than 8 months?

It is unclear whether these classes are provided predominantly by registered for-profit providers, registered non-profit providers, Government departments, or informal micro-enterprises (for- and/or not-for-profit). Research is needed to reveal South Africa's spend on extra lessons not provided by schools, and to determine the extent to which supplementary tuition is funded by parents and/ or other funding sources (e.g. corporate social investment, philanthropy, Government departments etc.), or provided free of charge by volunteers (e.g. teachers and students providing additional tuition during the hours after school).

This paper's findings and the many questions it sparks around the nature of South Africa's ASP sector underline the need for a national audit or census of extra lessons and after school providers, including whether they are formal or informal providers, the nature of their relationships with schools, as well as issues around provision, e.g. dosage, fees, and the number of learners served per grade. While the TIMSS data analysed in this paper focuses on grade 9 learners attending extra mathematics classes, there is a need to investigate the prevalence of shadow education across grades, phases and subjects.

In their chapter entitled "The Impact of COVID-19 on a Fragile Education System: The Case of South Africa", Soudien, Reddy and Harvey (2022) outline the pandemic's educational impact on learning loss, widening inequality and the erasure of learning gains made over recent years. With major learning losses due to school closures and rotational timetabling in South Africa (Ardington, Wills & Kotze, 2021), learners need supplementary support now more than ever. Soudien et al. (2022) note the implications of international research on gaps in instructional time for South Africa, highlighting that learning losses will likely be higher for mathematics than for reading, and that disdvantaged learners will experience greater learning losses. The authors develop a speculative model to estimate the impact of learning losses on 'TIMSS 2020' scores, and find that the achievement gains made since 1994 "would probably revert to the achievement levels recorded in TIMSS 2015 – a loss of five years of learning" (p.317). In order to recover from missed schooling and learning losses due to the pandemic, there is an urgent need for additional support to learners for catch up, and within this context, research is needed to explore whether ASPs can play a role.

A national audit of after school providers can inform policies and systemic interventions, connect and empower the sector, and provide the groundwork for further investigation into the kinds of programmes and models on offer. With its focus on serving under-resourced learners, the ASP sector could provide an opportunity to redress inequality in the system (YASPO 2020a; Olivier 2021).

8. Conclusion

Since 1995, TIMSS surveys have found participation in extra lessons in South Africa to be amongst the highest in the world. However, this has gone largely unnoticed and uninvestigated, with most research focusing solely on the formal system. Despite significant public expenditure, South Africa's education system was delivering dysmal educational outcomes before the COVID-19 pandemic wreaked devastating learning losses (Shepherd, Mohohlwane, Taylor & Kotze, 2021) and increased school dropout (Van der Berg, Van Wyk, Selkirk & Hofmeyr, 2021). Covid-19s disruption to schooling has likely eviscerated the small and yet steady gains achieved in education in recent years - for example, those outlined by Van der Berg, & Gustafsson (2019). It is time to bring South Africa's extensive after school programmes sector out of the shadows, to investigate its role in the education ecosystem, and to explore its potential for mitigaging learning loss and inequality.

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