THE IMPORTANCE OF SOCIO-ECONOMIC STATUS IN DETERMINING STUDENT ACHIEVEMENT IN MATHEMATICS: A LONGITUDINAL STUDY IN PRIMARY SCHOOLS IN GHANA

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ABSTRACT: *The Socio-Economic Status (SES) of families is an important determinant of child learning outcomes. The current study contributes to the debate on SES on learning outcomes. As part of a longitudinal study on teaching effectiveness in Ghana, this paper examines the effects of SES on child academic performance in mathematics. A representative sample of 73 primary schools in Ghana was selected and written tests in mathematics were administered to all grade 6 students of the school sample both at the beginning and end of the school year 2013–2014. Data on student background factors were also collected. Our analytical techniques (i.e., multilevel modelling) take into account the hierarchical structure of schools (i.e., students nested within classes, and within schools. The factors that stood out more clearly as important for achievement were prior knowledge in mathematics, mothers' educational level and fathers' occupational status. Implications of the findings are drawn.*

KEY WORDS: Child Socio Economic Status and learning achievement

INTRODUCTION

Socio-Economic Status (SES) contributes to the physical, economic and social well-being of individuals and families (Sirin, 2005). Children born into poor families face an educational disadvantage both before they enter school and throughout their education, such that SES to a large extent determines educational outcomes, which in turn determine the SES of the next generation (Willms, 2002; Willingham, 2012). More specifically, because the chances of poor children for success are lower, they are more likely to grow up to be poor themselves, thus perpetuating poverty into the next generation (Mayer, 2002). The analyses of inequalities in learning outcomes is therefore useful for identifying both the dimensions of SES that matter most for child learning (OECD, 2011).

Studies addressing these questions have been conducted in developed countries (e.g., Caro et al., 2009; Downey et al., 2004; Lee & Bowen, 2006; Ready, 2010; Sastry & Pebley, 2010), but little is known about this topic in African countries. Prior studies on this subject in Ghana (e.g., Abudu & Fuseini, 2013; NEA, 2013; Nyarko et al., 2014; Ntim, 2014) were based on cross sectional data. Moreover, these studies did not address the hierarchical nature of schools in their analysis. Cross-sectional studies are subject to many methodological limitations including sampling bias and confounding effects (Goldstein, 1998; Lee & Bowen, 2006). Particularly, failure to recognize the hierarchical nature of data in educational settings, or any setting for that matter, results in unreliable estimation of the effectiveness of schools and their practices, which could lead to misinformed educational policies (Goldstein et al., 1998). As part of a longitudinal study on teaching effectiveness in Ghana, this paper examines the effects of SES on child academic performance. It was envisaged that the findings might generate data from

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which effective policies and interventions can be crafted for improving the learning of all children, and particularly the disadvantaged.

Background

The Government of Ghana has since independence in 1957 made a number of reforms to the educational system with the aim to achieve efficiency, accessibility and equity in service delivery (MOE 2013). For example, the Free Compulsory Basic Education (FCUBE) reform initiative introduced in 1992 has achieved a number of gains: the gender gap in primary school enrolment has been virtually eliminated. Gender ratio is now almost 1:1. Also, 89% of children in the 6-11 age brackets now attend school (MOE 2013). However, the major challenge that remains is the stark inequalities in student performance. Over the years, results from both the National Education Assessment (NEA) and the Basic Education Certificate Examination (BECE) have consistently indicated that children of low SES background or those from rural areas lag behind their peers from the relatively well endowed families. For example, in the NEA 2013, urban grade 6 students achieved three times more than their rural counterparts in math proficiency (i.e., 21% versus 6%). Also, the percentage-point gap between girls and boys who reached the minimum competency in math and English language was 5.3 and 2.9 respectively (MOE**,** 2014).

In the current age of accountability, educational policy recognizes the importance of SES on child achievement by requiring evidence that student subgroups demonstrate levels of performance at par with one another (Dickinson & Adelson, 2014). Research derived predominantly from developed countries indicates that low SES and its correlates, such as lower parental education and poverty have an influence on the level of educational support for child learning (Duncan, Magnuson & Votruba-Drzal, 2014). Unfortunately, little research has been conducted on this topic in African countries including Ghana where inequality in terms of resources available to families is more pervasive. Prior studies in Ghana were primarily based on cross sectional data. Cross-sectional studies are subject to many methodological limitations including sampling bias and confounding effects; aggregation bias, misestimated standard errors, and heterogeneity of regression (Goldstein, 1998). A notable exception is Chowa, Masa, & Tucker, (2013) who used a longitudinal design in examining the impact of parental involvement in school based activities on student achievement in Junior High Schools.

The current study uses a longitudinal design by collecting data on student achievement in mathematics both at the beginning and end of a school year. Data on multiple student background factors (e.g., age, sex, parental education) were also collected. Our analytical techniques take into account the hierarchical structure of schools (i.e., students nested within classes, and within schools). Multilevel modeling techniques is used in analyzing the joint effects of multiple factors at the level of the students that interconnect to impact on achievement. This comprehensive approach makes the study a unique one in Ghana, if not the entire sub-Saharan African region. Specifically, we address the following question: 1) what are the effects of family SES on student achievement in mathematics. It was envisaged that the study might contribute to effective policies and interventions for improving the learning of all children, and particularly for disadvantaged children.

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LITERATURE REVIEW

The socio-economic status (SES) of families contributes to economic, social well-being and the learning of children (Sirin, 2005). Measures of SES, and statistics based on them such as variances, are necessary to quantify if not understand the level of any inequality in school children's performance (OECD, 2013). These differences are commonly referred to in the literature as achievement gap, opportunity gap or learning gap (Willms, 2002): First, achievement gap refers to output i.e. the unequal or inequitable distribution of educational results and benefits. Second, opportunity gap refers to input i.e. the unequal or inequitable distribution of resources and opportunities. Third, learning gap refers to the relative performance of individual students i.e. any disparity between what students have actually learned and what they were expected to learn at a particular age or grade level.

Academic performance gaps emerge very early in childhood learning, and may perpetuate throughout a child's school life (Mayer, 2002). Consequently, reducing achievement gaps has become a major equity issue for researchers and policy makers alike (OECD, 2013). Although schools are expected through quality teaching to reduce if not eliminate any gabs in student learning outcomes, there is a general agreement among educational researchers and scholars that factors both outside and inside schools interact to create achievement gaps among student groups (e.g., Creemers & Kyriakides, 2006; Desforges & Abouchaar, 2003). The genetic characteristics of the child i.e. sex, age, and aptitude have differential effects on achievement (Creemers & Kyriakides, 2006). Also, parental characteristics (e.g., genetic endowment, education, occupation, and income), believes and behaviors has an influence on child skill development, motivation and achievement (Eccles & Davis-Kean, 2005). Similarly, the school and its neighborhood conditions, the value for education by citizens and the resources available at the community level for learning also plays a part (i.e., Carlson, & Cowen, 2015). This study is concerned with the effects of student basic characteristics (sex, age, aptitude), parental characteristics (educational qualification, income and engagement), and school characteristics).

Student characteristics

Previous research has demonstrated the relation between student characteristics and academic achievement. In an analysis of Progress in International Reading Literacy Study (PIRLS) 2006 data for grade 4 students reading achievement, Martin, Mullis and Foy (2011) found a positive correlation (0.15) between student age and reading achievement. Also, a longitudinal study in England (Sylva, Melhuish, Sammons, Siraj & Taggart, 2014) found that older students showed significantly better results. Another longitudinal study in Canada (Caro, McDonald, & Willms, 2009) examined the trajectory of academic achievement gap of high and low SES students in mathematics achievement. Caro and colleagues reported a widening gap in achievement between students of higher and lower SES familiee: the gap remained fairly stable from the age of 7 to 11 years, but widens at an increasing rate from the age of 11 to the age of 15 years.

Studies have also shown that academic achievement by student sex tends to depend on the course subjects of study (i.e., language, math, or science). Whiles male students tend to outperform females in mathematics and science, with larger differences in science, females outperform males in reading and writing, with larger differences in writing (Davis-Kean 2005; Gustafsson, Hansen & Rosén, 2011; OECD, 2013; Voyer & Voyer, 2014). For example, in the PISA 2012 study, boys outperformed girls in mathematics by 11 score points (OECD, 2013). In contrast, in TIMSS and PIRLS 2011 there was no gender differences for mathematics

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or science achievement, but rather a substantial gender difference for reading achievement in favor of girls (Gustafsson et al., 2011). Similarly, in a meta-analysis of 502 effect sizes drawn from 369 samples on gender differences on teacher-assigned marks, Voyer and Voyer (2014) reported a small but significant advantage for female students, with the female advantage largest for language courses and smallest for courses on mathematics, science, and social sciences. Also, Sastry and Pebley (2010) examined children's reading and mathematics achievement with a sample in Los Angeles (USA). Girls scored significantly better than boys in reading, whiles for mathematics there was no significant differences between the two sexes.

Similar findings have been reported from studies with African samples. For example, Gustafsson, Hansen, and Rosén (2011) analyzes of TIMSS and PIRLS 2011 data revealed that girls had a higher level of achievement than boys in reading in Morocco and Botswana. In the SACMEQ (Southern and Eastern Africa Consortium for Monitoring Educational Quality) survey II (2000-2002) which assessed grade 6 students' achievement in mathematics and reading, girls on average attained significantly higher scores than boys in reading comprehension, but lower scores than boys in mathematics (Yu, 2007). Also, Chowa, Masa, and Tucker (2013) examined the effects of gender on the academic performance of Ghanaian Junior High School students for mathematics and English language. They reported that boys had slightly higher scores than girls in both subjects, and that the greatest difference was in mathematics where boys scored two points higher than the girls.

The aptitude of a child determines his/her readiness to profit from instruction (Haertel, 2010). Aptitude refers to any relatively stable child characteristic (i.e., cognitive or psychomotor ability, prior knowledge with subject matter, and IQ) that may be a predictor of achievement (Bailey et al., 2014; Kaufman et al., 2012; Walberg, 2003). Prior knowledge or achievement provides a clearer and precise predictor of future achievement, and a more useful basis from which instruction and guidance can be based (Hattie, 2012). It also determines how new information is understood, organized and stored in long-term memory for retrieval when needed (Slavin, 2014). According to Hattie (2012), the effect size of prior achievement is in the range of (d = 0.67), and that the brighter a student is at the beginning of the school year, the more he or she will achieve in the end.

Researchers have studied the longitudinal relations between children's early mathematics achievement and later achievement (e.g., Bailey et al., 2014; Watts, Duncan, Siegler, & Davis-Kean, 2014). Watts et al. (2014) studied the mathematical skills of preschool children up to adolescence in the USA. They reported that preschool mathematics ability predicted math achievement through to the age of 15, and that growth in mathematical ability between age 54 months and first grade is a stronger predictor of adolescent mathematics achievement. Also, in a longitudinal study in six European countries (Belgium/Flanders, Cyprus, Germany, Greece, Ireland, and Slovenia), Panayiotou et al. (2014) found student prior knowledge to significantly have an impact on achievement. Prior knowledge explained 41.8% and 46.6% of the total variance in science and mathematics achievement respectively (see also Vanlaar et al., 2015).

Parental education

The educational level of parents has an influence on the value placed on education, which in turn has an influence on the educational practices at home (Eccles & Davis-Kean, 2005). Educated parents tend to transmit to their children the academic culture they acquired at school, which can impact positively on child learning and performance (Mayer, 2002). Sylva et al.

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(2014) reported that better educated parents are able to raise their children to have healthy self-perceptions about their academic abilities, and engagement in intellectual activities, and that such parents also generally have children with fewer behavioral problems that can hinder their learning experiences. Also, Gustafsson et al. (2011) analyzes of TIMSS and PIRLS 2011 data revealed that children of more educated parents achieved statistically significant gains than their peers whose parents are not well educated. They reported that parents with higher levels of education involve their children in literacy activities to a larger extent than parents with lower levels of education.

Similarly, Davis-Kean (2005) reported that parental education is related to child achievement in math and reading indirectly through parental expectations and beliefs. And that that well educated parents had high expectations for their children, while at the same time adapting their expectations to the performance of their children. Also, as compared to father parents, the educational status of mothers was reported to be more related to higher amounts of math achievement. Also, Sastry and Pebley (2010) found that mothers' years of schooling were associated with 9% and 8% of total inequality in children's reading and math achievement respectively. Additionally, Eccles and Davis-Kean, (2005) reported that parents' general education (number of years of standard schooling) is linked to parents' language experience, which influences the ways in which they communicate with their children, which in turn exerts an influence on children's scores on tests of vocabulary and linguistic competence.

Additionally, Chevalier, Harmon, O' Sullivan, and Walker (2013) studied the extent to which early school leaving (at age 16) may be due to variations in permanent income and education. It was found that parental education levels are positively associated with good child outcomes. The effects were stronger for maternal education than for paternal education, and stronger for sons than for daughters. Also, Sylva et al. (2014) reported that children of highly educated parents fared better on social-behavioral outcomes such as self-regulation, pro-social behavior, hyperactivity and anti-social behavior, and that parental aspirations for child education was associated with students career aspirations at age 16. Hartas, (2011) reported that children with educated parents (degree level or vocational equivalent) were on average about six months ahead in language/literacy compared to their peers whose parents did not have any educational qualifications.

Similar findings have been reported from the context of African countries (Gustafsson et al., 2011; Howie et al., 2008). Using Structural Equation Modeling (SEM) techniques in analyzing TIMSS and PIRLS 2011 data, Gustafsson et al. (2011) reported statistically significant effects for parental education for Moroccan and Botswana students' achievement. For Moroccan students' achievement, the total effects of parental education was reported as 0.19, 0.19, and 0.24 for mathematics, science, and reading, respectively. For Botswana**,** the total effects of parental education were 0.41, 0.45, and 0.48 for mathematics, science, and reading respectively. Also, Howie et al. (2008) analysis of PIRLS 2006 data revealed that South African grade 4 and grade 5 learners whose parents reported having university degree qualifications or higher had better overall mean scores (378 (14.2) and 450 (14.3) at Grade 4 and Grade 5 respectively than learners whose parents had not completed degree programs.

Parental income

Parental income reflects the potential for social and economic resources that are available for child education (Mayer, 2002; Willingham, 2012). According to Mayer (2002), children of rich parents can be healthier, better behaved, better educated during childhood, while children

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from lower-income families have worse cognitive, social-behavioral and health outcomes. Whiles wealthier parents have the resources to provide more and better opportunities for their children, children of poor parents are subject to chronic stress, which is destructive to learning (Willingham, 2012). Moreover, poor parents lack the time to invest in their children, because they are more likely to be raising children alone or to work nonstandard hours or inflexible work schedules (Duncan et al., 2014).

Mayer's (2002) review of literature indicated that parental income is positively associated with child outcomes (i.e., cognitive test scores, socio-emotional functioning, behavioral problems, physical health, educational attainment, and future economic status), with largest effect being on cognitive test scores and educational attainment. Also, Dahl and Lochner (2012) analyzed panel data from a National Longitudinal Survey of Youth (NLSY) in the USA. They found income to have a significant effect on child math and reading achievement. Their estimated effects were larger for children from more advantaged backgrounds. Davis-Kean (2005) used Structural Equation Models (SEM) in examining how parental education and income relates to child achievement in math and reading. The author found small, indirect effect for income on achievement for both math and reading. Similarly, Cooper and Stewart (2013) sought to determine whether money is the cause of differences in child outcomes. They reviewed studies that used randomised controlled trials, natural experiments, instrumental variable techniques and longitudinal data from the US, UK, Canada, Norway and Mexico. As expected, they found that children in lower-income families have worse cognitive, social-behavioral and health outcomes.

If low parental income is a risk factor for child academic performance as indicated above, what policy options can address the problem. The investment model suggests that as parental income rises, parents purchase more child-specific goods and services which have the potential for improving child outcomes (Mayer, 2002). According to author doubling parental income, would on average increase children's cognitive test scores by about 10 percent of a standard deviation. Similarly, Dahland and Lochner (2012) estimates that a $1,000 increase in income raises math and reading test scores by 6 percent of a standard deviation in the short run, and that the gains are larger for children from disadvantaged families.

METHODS

Participants

The primary school population in Ghana is (N=19,854) made of public schools (N=14,112) and private schools (N=5,742). Gender parity ratio is almost 1:1, whiles teacher/pupil ratio is 1: 45 (MOE, 2012). The study was conducted in the Upper East Region, one of the ten regions of Ghana, which has a total school population of (N=701). Using the stage sampling procedure, three out of the ten districts of the region were randomly selected. Thereafter, schools (N=73) representing 10% of the school population in the region were randomly selected. Then, all grade six classes/teachers (N=99) and their students (N=4386) served as participants. Out of this sample, 55 schools were public whereas 18 were private. The chi-square test did not reveal any statistically significant difference between the research sample and the population in terms of school type (X^2=1.03, d.f.=1, p=0.09). In regard to the student sample, 49% were male and 51% female and the chi-square test did not reveal any statistically significant difference between the research sample and the population in terms of pupils' sex (X^2=0.95, d.f.=1,

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p=0.43). The sample is representative of primary schools in Ghana in terms of the background characteristics for which statistical data of this region are available.

Dependent Variable: Student achievement in mathematics

Ghana operates a centralized system with standard mathematics text books for use in all primary schools (MOE, 2007). The assessment of learning is however the responsibility of the schools and their teachers. For this reason, tests based on the prescribed curriculum were developed. To gain an accurate insight on the teaching and learning activities used in grade six in Ghana, specification tables were first developed for both the pre- and post-test measures capturing the salient themes in the curriculum and math text books. The test items tasks on basic operations, numbers and numerals, measurement of shape and space, collecting and handling data, and problem solving. The construction of the tests was subject to controls for reliability and validity (see Azigwe, 2015).

The pre-test measure was administered at the beginning of the school year in September 2013, whereas the post-test was administered at the end of the school year in July 2014. In both measures, the Extended Logistic Model of Rasch (Andrich, 1988) was used to analyze the emerging data to determine their reliability and validity. The analysis revealed that the scales in both measures had relatively satisfactory psychometric properties. Specifically, the indices of cases (i.e., students) and item separation were higher than 0.80. Moreover, the infit mean squares and the outfit mean squares were near one and the values of the infit t-scores and the outfit t-scores were approximately zero. Furthermore, each analysis revealed that all items had item infit with the range of 0.99 to 1.01. Rasch person scores for each student for each of the two measures were then generated for further analysis.

Explanatory variables: Student background factors

A questionnaire was designed for collecting data on student background characteristics. The grade six students completed the questionnaires during the school year in 2013. The response rate was recorded at 89%. The questionnaire elicited each students' demographic profile and family SES. The following were coded as dichotomous variables: student sex (0=boys, 1=girls); educational level of fathers and mothers (no education = 0; middle school = 1; secondary school=2; college/university or above=3) and occupational status of fathers and mothers (not employed, peasant farmer, laborer=0, commercial farmer, small scale business owner, public servant=1). The pre-test measure served as proxy for prior knowledge in mathematics.

RESULTS

The following steps are used in presenting the results. Descriptive statistics of the data is first presented to inform the reader on the general patterns of the student characteristics. This is followed by correlational analysis of student math achievement and background characteristics. Then we present multilevel analysis of the effects on student achievement by background factors.

Descriptive statistics

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The analysis is based on students who have scores in both the pre-test and post-test measures (N=3,585). Table 1 below presents descriptive statistics of student achievement by school type, school location, student sex and age. As can be observed in the table, the number of students is (N= 3586) out of which 49% are boys, while 51% are girls. The mean achievement in the post-test was -0.97 (SD=1.07), minimum -4.39, maximum 2.72. The larger the standard deviation implies that achievement among the students was heterogeneous. As can be observed in the table, based on the mean cores, it appears students in private schools did better than their peers in public schools. Whereas students in private schools had a mean score of -.23, students in public schools had a mean score of -1.23. Also, male students appear to do better than females, although the gab is not substantial. As expected, students in urban schools did better than their rural counterparts. Whereas students in urban schools had a mean score of -0.68, students in rural schools had a mean score -1.28.

Table 1: Student achievement by school type, location and gender

Variables		Frequency	%	Post-test score	
				Mean	Std. Deviation
Sex	Boys	1749	49	-.95	1.05
	Girls	1837	51	-1.00	1.09
Age	11 years or below	475	14	-.68	1.16
	12 years	777	24	-.84	1.10
	Above 12 years	2053	62	-1.03	1.08
School type	Public	2679	75	-1.23	.96
	Private	907	25	-.23	1.03
School location	Urban	1824	51	-.68	1.04
	Rural	1762	49	-1.28	1.01
Educational level mothers	No education	1661	50.4	-1.09	1.04
	Middle school	823	25.0	-.93	1.03
	Secondary school	583	17.7	-.82	1.05
	Post-secondary education	74	2.2	-.58	1.23
	Tertiary education	155	4.7	-.24	1.25
Educational level fathers	No education	1397	42.5	-1.11	1.00
	Middle school education	901	27.4	-1.01	1.03
	Secondary school education	424	12.9	-.84	1.07
	Post-secondary education	153	4.7	-.79	.99
	Tertiary education	412	12.5	-.40	1.22
Occupational status mothers	Unemployed , peasant farmer, petty trader	2706	82.1	-.97	1.05
	Public servant, nurse, teacher	591	17.9	-.77	1.18
Occupational status fathers	Unemployed, peasant farmer, petty trader	2329	70.5	-1.04	1.04
	Public servant, nurse, teacher	949	29.5	-.70	1.11

Also, as can be observed in the table, majority of parents do not have any educational qualifications at all, or have the minimum of middle or senior high school qualifications. Only 13% and 5% of fathers and mothers have tertiary qualifications respectively. Similarly, majority of parents are not engaged in any meaningful employment. As high as 71% and 82%

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of mothers and fathers are either not employed, are peasant farmers, or are laborers

Post-test									
Pre-test	.544**								
Gender	-.026	-.026							
Age	-.125**	-.030	.068**						
Schooltype	-.404**	-.392**	.005	.121**					
SchLoc	-.280**	-.211**	.009	.182**	.442**				
EduMothers	.184**	.059**	.006	-.368**	-.259**	-.334**			
EduFathers	.211**	.129**	.035*	-.094**	-.347**	-.334**	.432**		
OccuMothers	.022	.025	-.009	-.019	-.110**	-.149**	.274**	.268**	
OccuFathers	.136**	.118**	.009	-.027	-.187**	-.192**	.214**	.399**	.241**

respectively. Similar demographic profiles have been reported for grade six students in Ghana (Chowa et al., 2013). Also, based on the mean scores, the children on parents with higher educational levels and employment status achieved better results. For example, whereas the children of fathers with tertiary level education achieved a mean score of -.70, those of unemployed parents achieved a mean score of -1.04.

Correlation analysis

The IBM SPSS Statistics software was used to run bivariate correlation analysis between the variables and students' achievement at the alpha level of 0.01. Figure 1 presents a correlation matrix of student achievement in mathematics (post-test measure) and background characteristics. As can be observed in the figure, the correlation between achievement and the pre-test measure (prior knowledge) is statistically significant at the level of 0.01. School type and School location are also significant in favor of private schools, and schools located in urban areas. Educational level of mothers, educational level of fathers and occupational level of fathers are statistically significant in favor parents of students in the higher bracket respectively. On the other hand, gender and occupational status of mothers are not significant.

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed)

Figure 1. Correlation matrix of student math achievement and background characteristics

Multilevel analysis on the effects of factors on student achievement

The data is hierarchically structured (i.e., students nested in classrooms, classrooms in schools, and schools in turn nested in districts). The score gains of the students are linked to their schools (N=73), and school location (rural, urban). The hierarchical structure of the data makes multilevel modeling the appropriate technique for analyzing the data (Goldstein, 2003). The

MLwiN software (Goldstein et al., 1998) was used in conducting multilevel analysis on the effects on student achievement in mathematics by their background factors. A two level structure (i.e., students in level 1, classrooms in level 2) was used for the analysis.

The random intercept model was used in conducting two-level models where the intercepts represent random differences between groups (Goldstein, 2003). In a two-level model, the residuals in achievement are split into two components, corresponding to the two levels of the data structure (Leckie & Charlton, 2012). The first model is an unconditional or null model with no predictor variables. The model is referred to as a variance components model, as it decomposes the variation in the dependent variable into separate level-specific variance components (Leckie & Charlton, 2012) (see equation 0 below). In the second step, student background factors were added to the null model to determine their impact (equation 1). The models can be represented in following equations:

$$\text{Posttestscore}_{ij}=\beta_0 + u_j + e_{ij} \qquad (0)$$

$$u_j \sim N(0, \sigma_u^2)$$

$$e_{ij} \sim N(0, \sigma_e^2)$$

$$\text{Posttestscore}_{ij}= \beta_0+ \beta_1\text{Pretestscore}_{ij}+ \beta_2\text{StudAge}_{1j} +, \ldots, u_j + e_{ij} \qquad (1)$$

Table 3 below presents the results. As can be observed in the first column of the table (model 0), 55% of the variance in achievement is at the level of the classroom level, and 45% at the level students. This is an indication that an extremely high proportion of the variance in achievement lies at the classroom level. This finding seems to reveal that teachers matter more in Ghana than in other developed countries. Also, having established a significant variation in student achievement between the classrooms (teachers) justifies the need for a further examination of the factors accounting for this variation (Raudenbush & Bryk, 2002).

In this respect, in model 1, student background variables were added to the empty model. As can be observed in Table 3 (model 1), the pretest measure (a proxy for prior learning), educational level of mothers, occupational status of fathers, and student sex (in favor of male students) had statistically significant effects on students' achievement in mathematics ($p < .05$). On the other hand, student age, educational level of fathers, and occupational status of mothers were not statistically significant. Also, as can be observed at the bottom end of the table for model 1, 27% of the variance in student achievement was explained by the background factors, whiles 34% and 39% of the variance remained unexplained at the classroom and student levels respectively. The likelihood statistic (X^2) shows a significant change between the empty model and model 1 ($p<.001$) which justifies the selection of model 1.

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***Table 3*. Parameter estimates (and standard errors) for the analysis of student achievement in mathematics (students within classes).**

	Model 0	Model 1
Fixed Part (Intercept)	-0.994 (0.080)	-1.014 (0.086)
Students' context		
Pretest measure		0.369* (0.015)
Gender (female 1, male 0)		-0.055* (0.026)
Age of students		-0.014 (0.022)
Educational level of mothers		0.039* (0.015)
Educational level of fathers		0.008 0.011)
Occupational status of mothers		-0.062 (0.036)
Occupational status of mothers		-0.070* (0.030)
Random Part		
Classroom level	55%	34%
Students	45%	39%
Explained		27%
Significance test		
X2	8131	6737
Reduction		1394
Degrees of freedom		4
p value		.001

DISCUSSIONS

This study examined the effects of student SES on student achievement in mathematics. Our analysis utilizes more appropriate and sophisticated methods than the in previous studies in Ghana. Like other studies examining learning achievement in developing countries (e.g., Cho, Schermanm & Gaigher, 2014; van der Berg, 2008; Zhao, Valcke, Desoete & Verhaeghe, 2012), we found 55% and 45% of the variance in student achievement at the classroom and student levels respectively. For example, Cho et al. (2014) used multilevel modeling techniques in analyzing TIMSS 2003 data for science achievement of South African students and found 41% of the total variance in achievement to lie at the student level, whiles 59% was at the school/classroom level.

This finding further advances the critical role of school for mathematics learning (i.e., Teodorovic, 2009; Willms, 2003). According to Willms (2003), school is generally more important for the learning of science and mathematics since parents may lack the required

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knowledge to support child learning for those subjects at home. We argue that school may even be more important for mathematics learning in developing countries considering the relatively low levels of education in such countries. For example, in this study, majority of mother parents (50%), and father parents (42%) do not have any educational qualification.

There is broad agreement that good schools are those that have simultaneously high average achievement and an equitable distribution of achievement among students of different socio economic background (OECD, 2013). Student sex appeared important for mathematics achievement in our initial corelation analysis, as usually found in cross-sectional studies in Ghana (e.g., Buabeng et al., 2014; Chowa et al., 2013; NEA, 2013; Ntim, 2014). However, controlling for other factors such as prior achievement, these variables were no longer statistically significant. The variable that mattered most at the students' level was prior knowledge, which had a huge predictive effect on achievement (i.e., Hattie, 2012; Walberg, 2003). Also, the educational level of mothers, and occupational status of fathers remained significant predictors of student achievement after controlling for all other variables. Other studies have shown that the educational level of female parents is more related to higher amounts of math achievement as compared to male parents since mothers spend more of their time with children (e.g., Davis-Kean, 2005). Also, from the context of Africa, where male parents are the prime source of income for the family, it comes as no surprise that the occupational status of father parents remained a significant predictor of achievement in this study.

CONCLUSION

The study explored the joint effects of students' family SES variables on student achievement in mathematics. We advance prior research on SES in Ghana by drawing on a longitudinal design and applying regression techniques suited for school data. It was envisaged that the study might contribute to effective policies and interventions for improving the learning of all children, and particularly the disadvantaged children. At the student level, the factors that stood out more clearly as important for the learning in mathematics were student prior knowledge in mathematic, mothers' educational level and fathers' occupational status.

Our study is however our study is not without limitations. The study is based on students' responses about their family circumstances which may not be entirely accurate. Also, although our study explored the effects of several students' SES factors, other equally important variables such as students' beliefs, attitudes or motivation for learning are mediators between family SES and academic performance (i.e., Eccles & Davis-Kean, 2005). Future research on how such variables in addition combine to exert their influence on learning achievement is needed. Another limitation is the fact that the study is based on only mathematics. How the results generalize to other subject domain areas such as language demands further research. Further longitudinal studies are needed in Ghana that takes a holistic approach by exploring the joint effects of family SES and school characteristics on learning in other subject domains such as language. It is also important for studies in Ghana to use more appropriate analytic techniques such as multilevel for analyzing school data, since failure to recognize the hierarchical nature of data in educational settings can lead to misleading or unreliable results (Goldstein et al., 1998).

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The limitations notwithstanding, we are able to make recommendations that can improve child learning in Ghana and other countries of similar characteristics. The foregoing has highlighted those areas that are significant determinants of student performance and thus which areas should receive policy priority. The larger values of the intraclass correlation coefficient found here suggest that policy interventions are required earlier rather than later in the education process, as this high level of between school inequality arose before secondary school level. Although family SES is less amenable to policy in the short term, it is possible to understand how family SES affects school conditions and to use school conditions to compensate for differences in family SES (i.e., Hoff, 2003; O'Connor et al., 2007).

Children are hardest hit by family economic conditions during their early year**s.** This period is also when the brain develops critically important neural functions and structures that shape future cognitive, social, emotional, and health outcomes (i.e., Duncan et al., 2014). Unfortunately, disadvantaged or low income children are much less likely to have access to early learning opportunities than their more affluent peers. In Ghana, policy initiatives such as school feeding, free school uniforms are already being implemented in select poor communities. The faster these programs can be spread to cover many more needy children, the better it will be for reducing the learning gabs. Also, much more intensive program such as school nurseries that provides early care and educational experiences for poor communities can be fruitful. Providing at least one year of quality pre-school education to all students is likely to improve student performance. This is especially true for poorer students who would otherwise start primary school at a disadvantage, and a disadvantage that is unlikely to diminish throughout their schooling career. Improving the quality of preschool education offered to the poor is also necessary if the full benefit of this policy intervention is to be felt.

The social capital theory posits that a family's potential to develop human capital can benefit from relationships with other members of the community, particularly when members of the family's social network have access to special knowledge or resources (Mayer, 2002). From this viewpoint, schools can serve as active agents by affording opportunities for parent to parent interactions, and as well an interface with school and teachers for informed home based learning activities (i.e., Desforges & Abouchaar, 2003). In a developing country such as Ghana, where parents and family sources may lack the requisite capability to assist children in school work, this type of interaction might be the only way for parents to gather information about how best to help child learning.

Also, as established in the study, the school is especially very important for the learning of mathematics. Therefore, educational authorities, schools and teachers can take concrete actions to increase and improve the quantity and quality of time children spend in mathematics and science courses since parents may not have the capacity to help in these courses at home. For example, extra afterschool learning programs targeted at students of low SES families can be a useful option. Also, children in schools have different skill levels, and motivation, in part because they are exposed to different home environments and neighborhood conditions (Downey et al., 2004; Hanushek et al., 2003). Therefore, classroom teachers can maximizes the potential benefits of peer group interactions and learning, whiles working as much as possible to reduce if not eliminate any negatives that may also stem from differences in children.

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