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THE MEDIATING EFFECTS OF HOME LEARNING ON STUDENT ACHIEVEMENT IN MATHEMATICS: A LONGITUDINAL STUDY IN PRIMARY SCHOOLS IN GHANA

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ABSTRACT: *The home learning environment as mediated by parental education and income is an important determinant of child learning outcomes. As part of a longitudinal study on teaching effectiveness in Ghana, this paper examines the joint effects of multiple variables related to home learning environment that interconnect to impact 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). Controlling for the more basic student background factors, we find that the provision of learning resources at home, whiles ensuring that children are offered learning opportunities after school time were important. Implications of findings are drawn.*

KEYWORDS: Home, Learning, Environment, Student, Achievement.

INTRODUCTION

One of the most stable and consistently observed phenomena in the field of education is the impact of students' home background on achievement (Creemers & Kyriakides, 2008). Students whose parents have a higher level of education, a more prestigious occupation, or greater income tend to have higher achievement than students whose parents have a lower standing on such socio-economic status (SES) indicators (Sirin, 2005). On the other hand, 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 and the pathways through which key dimensions of SES operate (OECD, 2011). 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 where inequality in terms of resources available to families for child education is more pervasive. Prior studies on this topic in Ghana (e.g., Abudu & Fuseini, 2013; NEA, 2013; Nyarko et al., 2014; Ntim, 2014) were primarily based on cross sectional data. Cross-sectional studies are subject to methodological limitations including sampling bias and confounding effects, misestimated standard errors, and heterogeneity of regression (Goldstein, 1998). A notable exception is Chowa, Masa, and 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.

As part of a study on teaching effectiveness in Ghana, this paper examines the effects of home learning environment on child academic performance. The 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 background factors (e.g., student SES, home learning) were also collected. Our analytical techniques take into account the hierarchical structure of schools (i.e., students nested within classes, and within schools) (Goldstein, 1998). The multilevel modeling technique is used in analyzing the joint effects of multiple factors at the level of the students that interconnect to impact on achievement.

Specifically, we address the questions as to whether the home learning environment has an effect on student achievement independent of parental education and income (e.g. Eccles & Davis-Kean, 2005; Melhuish, 2010). 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. In next to follow, we review the literature to put in perspective what has gone before and to demonstrate some awareness of the current state of knowledge on the study. This is because Baker, (2001) asserts that the first step in any research project must be to establish what is already known about the topic or problem as knowledge accumulates over time. Additionally, since knowledge does not exist in a vacuum, this study will only have value if it relates to what other people have written before it (Jankowicz, 1999).

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 (i.e., 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). In next to follow, we divide the topic into research that examines the effects of student basic characteristics (sex, age, aptitude), parental characteristics (educational qualification, income and engagement), and school characteristics).

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 impacts positively on child learning and performance (Mayer, 2002). Sylva et al. (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 further found 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.

Similarly, Chevalier et al. (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 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, whiles total indirect effects were 0.00, 0.03, and 0.05. For Botswana**,** the total effects of parental education were 0.41, 0.45, and 0.48 for mathematics, science, and reading respectively, whiles the corresponding total indirect effects were 0.09, 0.10, and 0.10. 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 from lower-income families have worse cognitive, social-behavioral and health outcomes. Also, whereas wealthier parents have the resources to provide more and better opportunities for their children, the reverse is the case for poor children who can be subjected to chronic stress, which is destructive to learning (Willingham, 2012). Moreover, poor parents lack the time that wealthier parents have 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, indirectly relates to child achievement in math and reading through parental beliefs and behaviors. The author reported small, indirect effect for income on the 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 Mayer 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.

Parental Engagement

Parental engagement consist of activities such as attending or volunteering in school activities, communicating with teachers and other school personnel, and assisting in academic activities at home (Desforges & Abouchaar, 2003; Eccles & Davis-Kean, 2005; Emerson, Fear, Fox & Sanders 2012; Hill & Taylor, 2004). Emerson et al. (2012) set parental engagement into three categories: First, academic socialization which includes communicating with children about expectations for education; discussing learning strategies with children, and linking school work to current events; fostering educational aspirations and making preparations and plans for the future; and providing a stimulating home learning environment. Second, parental role construction which is a sense of personal or shared responsibility for child educational outcomes, and parental beliefs about being involved in child's learning; and sense of efficacy for helping child success in school. And third, supportive parenting style which is to set rules and limits for child behavior, and the same time, making transparent the reasons behind decisions, which can lead to child autonomy and self-responsibility.

Similarly, Hill and Taylor (2004) view parental engagement from two perspectives. First, social capital is parental skills and information on school policies and practices, networking between schools or teachers with parents, and parent-to- parent collaboration. This collaboration equips or builds the capacity of parents to assist children in school-related activities. Second, social control is when families and schools work together in building consensus on appropriate school and home behavior, which is effectively communicated to children. According to the authors, when there is consensus from parents on appropriate behavioral and academic goals, social constraint is achieved, and that, when children and their peers receive similar messages across settings and from different sources, the messages becomes clear and salient, and thus reduces confusion about expectations.

Parental involvement in child learning practices has been argued as is more a powerful force for child academic success than other family background variables, such as social class, family size and level of parental education and income (Emerson et al., 2012; Walberg & Paik, 2000). The major reason being that from infancy until the age of 18, children spend approximately 92% of their time outside school under the influence of their families or parents (Walberg & Paik, 2000). Parental engagement has a positive impact on indicators of achievement including higher grades and test scores, enrolment in higher level programs and advanced classes, higher successful completion rates (Emerson et al., 2012): Beyond academic performance, parental engagement is also associated with regular school attendance, better social skills, improved behavior, better adaptation to school, increased social capital, and a greater sense of personal competence and efficacy.

In a meta-analysis of randomized controlled trial (RCT) studies on parent involvement on elementary school-age children's achievement for reading, math and science between the period of 1966 to 2003, Nye, Turner and Schwartz, (2006) found a positive and significant effect for parental engagement on achievement. The effect sizes were reported at d=0.42, d=0.54, and d=0.75 for reading, math and science respectively. Also, Chowa et al. (2013) used structural equation modeling techniques in studying the effects of parental engagement on academic performance for Mathematics and English language with a random of sample

Ghanaian Junior High School students. They reported that parental involvement in both home and in-school activities were statistically significant in effects on performance. They also reported that while "at-home" parental involvement was associated positively with academic performance, in-school involvement was negatively associated with performance.

Parental engagement also varies according to parental education and income. Educated parents tend to transmit to their children the academic culture they acquired at school which can have a positive impact on the performance of children (Mayer, 2002). Such parents are more likely to hold high expectations for their children's achievement, and to be more often engaged in promoting child learning (Walberg 2003). Eccles and Davis-Kean, (2005) found that higher level of parental education is associated with better economic and psychological outcomes (i.e., more income, more control, and greater social support and networking). They also reported that such parents have more confidence in their children's academic abilities, and that child academic performance is benefited to the extent that parents have high confidence in their abilities. Similarly, Lee and Bowen, (2006) examined the impact of parent involvement with a sample of fifth graders in southeastern USA. They reported significantly higher academic achievement for students of more educated parents, and for those not living in poverty. They also reported that parent-child discussion occurred more frequently with non poor homes, and also in the homes of the highly educated parents.

Also, the structure of the home environment and the level of parent/child academic interaction are influenced by the level of parental education and income (Davis-Kean, 2005; Hartas, 2011). In families experiencing socio-economic disadvantage, the effectiveness of home learning, and the educational experiences generated through it can be compromised due to limited access to educational resources (Hartas, 2011). Also, the home environment of low SES children tend be characterized by less dialogue from parents, minimal amounts of book reading, and few instances of joint attention (Davis-Kean, 2005).

Researchers have found substantial differences in home literacy environments of children from high and low SES families, which in turn explain educational differences between the two groups of children (e.g., Gustafsson et al. (2011)). Melhuish (2010) analysis of longitudinal data (i.e., Growing Up in Scotland) revealed that children with a higher scores in home learning environment were more likely to be overachievers in Naming Vocabulary and Picture Similarities, while lower scores of SES were associated with under-achievement. Also, Gustafsson et al. (2011) noted that parents with higher levels of education involve their children in literacy activities to a larger extent than parents with lower levels of education, and these literacy activities in turn have a positive effect on reading achievement.

Parents can create a stimulating home learning environment with what Walberg (2003, p: 9) calls "the alterable curriculum of the home". According to Walberg, the home curriculum includes informed parent to child conversations about school and everyday events; encouragement and discussion of leisure reading; monitoring, discussion, and guidance of television viewing and peer activities; deferral of immediate gratification to accomplish long-term goals; expressions of affection and interest in the child's academic progress. The provision educational resources at home (i.e. books and other reading material materials, computers, desk for studies), and other activities such as reading to the child, using complex language, playing with numbers, counting, and taking the child to the library can also improve the home learning environment (Melhuish, 2010). Also, designating an area for homework, and helping with studies, supervising and monitoring how children spend their time after school are also important (Gustafsson et al., 2011; Henderson & Mapp, 2002). Howie et al. (2008)

analysis of PIRLS data of South African Grade 4 and 5 learners indicated that learners with more books achieved higher mean scores (321 (17.0) and 360 (16.4) at Grade 4 and Grade 5 respectively in comparison to those who did not (239 (3.9) and 285 (4.2).

METHODS

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 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 covered 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

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 first section elicited each student's demographic profile and family SES. The second section elicited information about parental support for home study, learning materials at home, and parental attitudes for learning.

Basic student background variables: 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).

Household economic durables: In measuring this variable, an attempt was made to include more culturally valid indicators of social and material assets (i.e., Lockheed, Fuller & Nyirongo 1988). As such, as well as the conventional household economic assets (e.g., refrigerator, television, bicycle) , variables such as access to water, transportation, house type, waste disposal, land and live stock ownership were taken into account. The emerging data were

analyzed with Principal Component Analysis to determine the weight for each of the items and an index was created (see Azigwe, 2015).

Home learning materials: The students indicated if they have a quiet place at home for learning; and the language usually spoken at home (e.g., I speak my local dialect almost always at home, or I speak English language almost always at home) (coded Yes= 1; No= 2). A list of learning materials was also provided from which the students indicated those available in their homes (e.g., I have a desk, math books, or a computer at home for studies). The emerging data were also analyzed with Principal Component Analysis and an index was created for each student.

Opportunity to learn - Homework: A Likert scale type items were provided for the students to indicate parental support for homework and private tuition. From the emerging data, an index was created for each student for learning opportunities (i.e., home work and private tuition).

Parental support: An aspect of the Likert scale measured parental attitude for learning. Confirmatory Factor Analysis was carried out building on a three factor solution. This three-factor structure attained satisfactory goodness-of-fit indices (x^2 = 274.48, df = 24, p-value < .00, CFI = .96, RMSEA = .05, Alpha = .77) and the following factors were created: a) *Parental attitude towards mathematics* (e.g., my parents believe it is important for me to study mathematics; my parents like mathematics), b) *Monitoring children's progress* (e.g., my parents make sure I did my homework before I sleep; my parents study my terminal reports to check my performance). c) *Parental care after school time* (e.g., my parents know where I go after school; when I leave the house my parents ask me where I am going).

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 and variables related to their home learning environment. This is followed by multilevel analysis of the effects on achievement by the factors.

Descriptive Statistics

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 student sex, age and variables the home learning environment . 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, male students appear to do better than females, although the gab is not substantial.

Table 1: Student achievement by gender and age

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

Table 2 presents descriptive statistics of continues variables such as Household economic assets, Learning materials, Home work, and Parental care for the child. As can be observed in the table, the variations in these variables are large enough to allow for identification in the analysis. For example, the mean of household asset index for the full sample is 3.16 (SD= 2.66) with a range of .0 to 9. It is important to note that the zero minimum values reported for some of the variables do not mean a lack of those resources, but rather a relatively fewer ownership of those resources.

Table 2: Descriptive statistics, the home learning environment

Variables	Number	Min	Max	Mean	Std. Deviation
Economic household items	3112	0.0	8.0	3.16	2.66
Quiet place for learning at home	3296	0.0	1.0	0.43	0.49
Language at Home	3299	1.0	2.0	1.08	0.27
Learning materials at home	3308	0.0	4.0	1.49	1.16
Home work	3173	1.0	5.0	2.47	1.43
Private tuition	3143	1.0	5.0	1.95	1.40
Parental attitude towards Maths	3294	1.0	5.0	3.08	1.25
Monitor performance	3288	1.00	5.00	3.26	1.06
Care after school time	3227	1.0	5.0	3.50	1.19
Know and care ParFriends	3256	1.00	5.00	2.82	1.09

Multilevel analysis on the effects of student background factors on 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). 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. 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 control for their impact prior to determining the effects of variables related to the home learning environment (equation 1). Then in model 2, the variables related to the home learning environment were added to determine their impact on achievement. The models can be represented in following equations:

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

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

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

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

$$\text{Posttestscore}_{ij}= \beta_0+ \beta_1\text{Pretestscore}_{ij}+ \beta_2\text{StudAge}_{1j} +,\text{Home learning...}\ u_j + e_{ij} \quad (2)$$

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/schools 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, 31% of the variance in student achievement was explained by the background factors, whiles 30.8% and 37.7% 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.

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

	Model 0	Model 1	Model 2
Fixed Part (Intercept)	-0.994 (0.080)	-1.014 (0.086)	-1.219 (0.117)
Students' context			
Prior knowledge (Pre-test measure)		0.369* (0.014)	0.360* (0.014)

Student sex (male reference category)		-0.055* (0.024)	-0.051 (0.026)
Age of student		-0.014 (0.020)	-0.002 (0.022)
Educational level of mothers		0.039* (0.015)	0.046* (0.016)
Educational level of fathers		0.008 (0.011)	0.004 (0.013)
Occupational status of mothers		-0.062 (0.036)	-0.066 (0.039)
Occupational status of fathers		0.071* (0.030)	0.084* (0.033)
Home learning environment			
Quiet place to learn at home			0.041 (0.027)
Language at home			0.002 (0.055)
Economic household goods			0.000 (0.006)
Learning Materials (Books)			0.042* (0.014)
Homework			-0.015 (0.010)
Private tuition			-0.019 (0.10)
Attitude towards math			-0.002 (0.013)
Check on performance			-0.001 (0.017)
Children are offered learning opportunities after school time			0.050* (0.013)
Random Part			
Classroom	54.9%	30.8%	30.7%
Students	45.1%	37.7%	37.4%
Explained		31.5%	31.7%
Significance test			
X2	8131	6737	5791
Reduction		1394	2340
Degrees of freedom		3	2
p value		0.001	0.001

Note *=statistically significant at the 0.05 level

In model 2, the variables related to the home learning environment were added to model 1. As can be observed in table, the column under model 2, learning opportunities offered to the child after school time, and learning materials such as books at home had statistically significant effects on achievement. On the other hand, quite place to learn at home, language at home, economic durable goods, home work, private tuition, attitude towards math, checking on child performance are not statistically significant. Notably, although not significant, private tuition

and home work had negative effects on learning. Also, as can be observed at the bottom end of the table for model 2, 31.7% of the variance in student achievement was explained by the variables related to home learning, whiles 30.7% and 37.7% of the variance remained unexplained at the classroom and student levels respectively. Also, the likelihood statistic (X^2) also shows a significant change between and model 1 and model 2 ($p<.001$) which justifies the selection of model 2.

DISCUSSION

This study examined the effects of student home learning environment on 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 school/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.

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). This finding further advances the critical role of school/teachers for mathematics learning (i.e., Nye et al., 2006; 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 knowledge to support child learning of 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 parental education in such countries. For example, in this study, majority of mother parents (50%), and father parents (42%) do not have any educational qualification.

Also, prior knowledge or achievement provides a clearer and precise predictor of future achievement, and as well a more useful basis from which instruction and guidance can be based (Hattie, 2012; Walberg, 2003). It also determines how new information is understood, organized and stored in long-term memory for retrieval when needed (Slavin, 2014). In this study, the variable that mattered most at the students' level was prior knowledge, which had a huge predictive effect on achievement. Also, the educational level of mother parents, and occupational status of father parents 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 African culture, 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 student achievement in this study.

Turning now to the substantive objective of the study as to whether the home learning environment has an effect on achievement net of other background factors. The analyses showed that a measure of the home learning environment added to an understanding of the influences that might affect a child's achievement at school. While other family factors such

as parents' education and occupation are important, the extent of home learning activities exerts an independent influence on child learning. This finding is supported by studies from studies in developed countries (e.g., Davis-Kean, 2005; Hartas, 2011; Melhuish et al., 2008) and developing countries (e.g. Chowa et al., 2013, Spaull, 2012).

Additionally, the study indicates that as against other more general household economic items (e.g., television, cellular phone, and bicycle), what is relevant is the provision of learning materials (e.g., math books, reading material materials) at home for child use. Also, offering learning opportunities after school time for children is also the most relevant among the parental engagement variables. Ironically, although not statistically significant, parental support for home work and private tuition turned out to correlate negatively with achievement. Similar findings were reported in studies with African samples (e.g., van der Berg, 2008; Chowa et al. 2013; Spaull, 2012). For example, Chowa et al. (2013) analysis of data on Ghanaian Junior High School students' achievement in English language and mathematics found a negative effect on achievement for home work. The negative effect for home work and extra tuition as found in this study probably indicates that the students were weaker in academic performance to start with; and thus needed extra tuition, rather than a negative impact of additional teaching and learning at home (e.g., Spaull, 2012).

CONCLUSION

The study explored the joint effects of multiple variables at the student level, and particularly, variables related to home learning environment on student mathematics achievement from the perspective of Ghana. We advance prior research on this topic in Ghana by drawing on a longitudinal design and applying regression techniques suited for school data (i.e. Goldstein, 2003). Multilevel modeling techniques were used in examining the joint effects of multiple factors related to student background factors and home learning environment that interconnect to impact on students' learning gains in mathematics. 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.

The first step was to control for student prior knowledge in mathematics (pretest measure) and other basic background factors such as age, sex, parental education and occupation as a step for determining whether the home learning variables have independent effects on achievement. The factors that stood out more clearly as important were prior knowledge, mothers' educational level and fathers' occupational status. Then in the next step, the effects of variables related to the home learning environment were determined. Here what stood out as more important is the provision of learning resources at home (e.g., books and other reading materials), whiles ensuring that children are offered learning opportunities after school time (e.g., parental concern for what children do and go after school time).

Our study is however is not without limitations. The study is based on students' responses about their family circumstances which may not be entirely accurate. 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; Melhuish, 2010). 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. More importantly, longitudinal studies are needed 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. The benefits of longitudinal studies are that they allow the investigation of issues of stability and change in the outcome variable over time; and thus provide a better basis for inferences about causality (Gustafsson, 2010).

The limitations notwithstanding, we are able to make recommendations that can improve child learning in Ghana and 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). Also, children are hardest hit by family economic conditions during their early years**.** This period is also when the brain develops critically important neural functions and structures that shape future cognitive, social, emotional, and health outcomes (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.

To this end, in Ghana, policy initiatives such as school feeding, subsidized school fees, free school uniforms and sandals 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 learning gabs. Also, much more intensive program such as school nurseries that provides early care and educational experiences for poor children can be fruitful. Providing at least one year of quality pre-school education to all students is likely to improve child 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 (Duncan et al., 2014). Moreover, improving the *quality* of preschool education offered to the poor is 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 families 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 this 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 teaching 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. Turning now to parents, it is important to note that whiles the provision of household durable goods (e.g., refrigerator, television, bicycle) is important, what matters most for child learning is the provision of learning materials (e.g., books and other reading materials) at home and ensuring that such materials are used by children for learning at home.

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