



Teacher Characteristics and Children's Educational Attainment in Ghana: Do Some Teacher Characteristics Matter More for Children Attending Disadvantaged Schools?

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This study examined the association between teacher characteristics and primary school children's educational attainment. Additionally, it explored whether certain teacher characteristics are more important for children attending disadvantaged schools. Multilevel analyses of linked administrative data on teacher characteristics and attainment indicate socio-economic differences in children's educational outcomes. Teacher certification and experience were associated with children's attainment in both Mathematics and English language. Findings exploring the differential effect of teacher characteristics show that teacher certification and experience were more important for the attainment of children attending rural and public schools. The results have significant implications for teacher professional development and deployment policies to improve attainment for all learners.

Keywords: teacher effectiveness, educational attainment, socioeconomic disadvantage, disadvantaged schools, teacher characteristics, educational inequality

INTRODUCTION

This study is concerned with understanding primary school children's educational attainment and the role that teachers can play. Internationally, learning assessments across low and middle-income countries indicate that large numbers of students leave primary school without developing the most basic competencies in reading and numeracy (Hungu, 2011; Bashir et al., 2018; World Bank, 2018). For example, the United Nations Educational, Scientific and Cultural Organisation (2018) reports that 268 million children globally are functionally illiterate and innumerate despite 50% of them having spent at least 4 years in school. Existing research suggests that student characteristics, family and home environment, as well as teacher characteristics and school factors influence students' learning and academic attainment (Hattie, 2009; Meyer and Benavot, 2013; Nilson and Gustafsson, 2016). Among school-related factors, it is argued that teacher qualities make the greatest contribution to students' learning (e.g., Barber and Mourshed, 2007; Organisation for Economic Co-operation and Development, 2012; World Bank, 2018). Teacher characteristics found to be associated with children's learning across different contexts

include academic and professional qualification (e.g., Palardy and Rumberger, 2008), teaching experience (e.g., Gerritsen et al., 2017; Ladd and Sorenson, 2017), and teachers' classroom practices (e.g., Glewwe and Kremer, 2006; Kingdon and Aslam, 2011; Azigwe et al., 2016). However, there is continuing debate regarding which teacher characteristics contribute most, singly or jointly, to students' attainment (e.g., Hattie, 2009; Burroughs et al., 2019). This lack of consensus is highlighted by Glewwe and Kremer (2006) who contended:

“[the] identification of the characteristics and practices of teachers that contribute most toward improving pupil attainment has often eluded researchers even though the most effective means of improving school quality may be through addressing weak teaching” (p. 995).

Overall, research on teacher characteristics and students' educational attainment is an emerging area of policy interest in low and middle-income countries in view of the desire to achieve quality education for all (United Nations, 2015; World Bank, 2018).

In addition to improving students learning outcomes, teacher qualities are also important in mitigating socio-economic inequalities in children's educational attainment (Organisation for Economic Co-operation and Development, 2012). Children from disadvantaged backgrounds have little access to educational resources, and are less likely to have someone with the educational experience to successfully support and mentor them at home (Mtika and Payne, 2014; Ivaniushina and Aleksandrov, 2015; Sosu and Schmidt, 2017; Mtika, 2019). Teachers are therefore arguably the most readily available significant individuals in the educational development of these children. However, it is unclear which teacher characteristics may help to improve the educational attainment of children from disadvantaged backgrounds. The current study aims to examine the teacher characteristics that influence student educational attainment, and explore whether certain teacher qualities matter more for children attending disadvantaged schools in Ghana. The study contributes to a better understanding of the role of teacher characteristics in addressing equitable access to quality education.

In what follows, we briefly review the literature on teacher characteristics and students' educational attainment, as well as examine whether these teacher qualities address the educational inequality gap associated with attending disadvantaged schools. We then present the context of the current study followed by methodology, findings, and discussion.

Teacher Academic Qualification, Professional Background, and Experience

Research on teacher effectiveness has received considerable attention in view of the need to improve learning outcomes for children around the world. Evidence shows that there is a 'teacher effect' on pupils' learning (e.g., Altinok, 2013; Meyer and Benavot, 2013). However, there is little consensus about the specific teacher qualities that lead to greater pupils' learning (e.g., Wayne and Youngs, 2003; Hattie, 2009; Burroughs et al.,

2019). Additionally, teacher characteristics can be examined at macro or micro levels, with macro level factors focusing on teacher credentials, while micro factors focus on teachers' behavior within the context of the classroom (Azigwe et al., 2016). In this study, we take advantage of the availability of unique administrative datasets in Ghana to explore the association between teachers' macro level characteristics and children's educational attainment. We argue that these macro level factors are important determinants of teachers' practice. Our review of previous studies on teacher characteristics suggests that effective characteristics cluster around, (a) professional training or certification, (b) teacher experience, and (c) teacher academic qualification.

Studies on teachers' *professional qualifications or certification* suggest significant associations between teacher certification and students' educational attainment (Darling-Hammond et al., 2005; Palardy and Rumberger, 2008; Tatto et al., 2012; Bhai and Horoi, 2019). Using the Early Childhood Longitudinal Study (ECLS) dataset, Palardy and Rumberger (2008) found that certification was positively associated with reading attainment in the early years. A study by Bhai and Horoi (2019) equally found that students taught by teachers holding a professional qualification outperformed their peers who were in classes taught by unqualified teachers in both Mathematics and reading. This suggests that having a teaching certificate is necessary for improved student attainment. However, other studies have found inconsistent associations between teacher qualification and different forms of student attainment (Humble and Dixon, 2017). One argument is that having a teaching certificate is a necessary but not a sufficient condition for effective teaching (Cochran-Smith et al., 2012). Despite the lack of consensus, fully qualified and certified teachers are more likely to have a significant impact on children's academic attainment than teachers without this preparation (Cochran-Smith and Zeichner, 2005). This is because those with a professional qualification tend to be equipped with the knowledge, attitudes and pedagogical approaches that facilitate learning (e.g., Sosu et al., 2010; Conn, 2017).

Research on the association between *teaching experience* and students' educational attainment has produced mixed results (e.g., Rice, 2013; Papay and Kraft, 2015; Blömeke et al., 2016). The impact of teaching experience on learners' outcomes also depends on many factors such as teaching in a supportive and collegial working environment, same grade level, subject, location and socio-economic characteristics of students (Huang and Moon, 2009; Hansen and Gustafsson, 2016; Podolsky et al., 2019). Some studies suggest that teaching experience is positively associated with student attainment gains (Harris and Sass, 2011; Gerritsen et al., 2017; Ladd and Sorenson, 2017; Bhai and Horoi, 2019; Podolsky et al., 2019). Using data from 4,000 teachers in North Carolina, Clotfelter et al. (2006) concluded that teacher experience was positively related to student attainment in both reading and Mathematics. Similarly, Kane et al. (2008) found a statistically significant positive relationship between teaching experience and pupils' attainment, while controlling for student, classroom, and school characteristics. An explanation for the teacher experience effect is that experienced teachers are able to adapt and tailor their teaching to suit students of different

abilities, prior knowledge and backgrounds. They also have a richer background to draw on to inform their teaching, may have mastered the content, and acquired classroom management skills to deal with different learning scenarios (Wolff et al., 2017; Podolsky et al., 2019).

Other studies, however, find negative (Humble and Dixon, 2017) or no significant association between teaching experience and learners outcomes (Nye et al., 2004; Rivkin et al., 2005), while some suggest a non-linear relationship between teacher experience and student attainment whereby teacher experience is important only up to a point and plateaus (Staiger and Rockoff, 2010; Toropova et al., 2019). For example, Toropova et al. (2019) found that teaching experience was positively associated with student attainment from the early years of teaching until the nineteenth year of experience and thereafter there is no change. This is consistent with earlier studies (e.g., Chingos and Peterson, 2011; Harris and Sass, 2011; Papay and Kraft, 2016) and challenges the widespread notion that the positive impact of teaching experience plateaus out after just a few years (usually 4–5 years) in service (Murnane and Steele, 2007; Rice, 2013).

Research on teacher *academic qualification* has also produced mixed findings in relation to children's educational attainment. A review by Barber and Mourshed (2007) found that the top performing education systems around the world recruited their teachers from the top third of each cohort of graduates. It is argued that teachers with higher academic qualifications tend to promote a culture of high expectations and school success for learners. They are more likely to use a diagnostic approach to support children's learning needs (Organisation for Economic Co-operation and Development, 2012). However, other studies examining teacher academic qualifications found no or negative association between higher degrees and student attainment (Clotfelter et al., 2006, 2010; Bhai and Horoi, 2019). For instance, Bhai and Horoi (2019) found no significant difference in Mathematics and reading attainment of students taught by teachers with Masters and or advanced degrees and those taught by teachers with a lower qualification. Additionally, some studies (e.g., Glewwe and Kremer, 2006; Kingdon and Aslam, 2011) have suggested that teachers' classroom practices and personal dispositions may be more important to student learning than teachers' observed characteristics such as academic qualification.

Disadvantaged Schools and Inequalities in Educational Attainment

Evidence across the globe indicates that children living in poverty attain significantly lower educational outcomes compared to their more affluent peers (e.g., Sosu and Ellis, 2014; Spaul and Kotze, 2015; Burroughs et al., 2019; Kim et al., 2019). While this poverty-related attainment gap has historically received little attention in low to middle-income countries, more recently, reducing this inequality gap has become a major area of focus (United Nations, 2015; World Bank, 2018), and is emphasized in the Sustainable Development Goal 4 (United Nations Educational, Scientific and Cultural Organisation, 2015). Evidence suggests that teacher effect on educational outcomes may be greater for children from disadvantaged backgrounds (Organisation

for Economic Co-operation and Development, 2012). This is because children from disadvantaged backgrounds do not always have the resources within their households to enrich their educational experiences (Banerjee, 2016; Sosu and Schmidt, 2017). Additionally, children living in poverty are less likely to have someone with the educational experience to either help with learning at home or navigate the complex educational terrain and post-schooling opportunities (Mtika and Payne, 2014; Ivaniushina and Aleksandrov, 2015; Mtika, 2019).

Few studies have examined whether certain teacher characteristics are associated with improved educational outcomes for children from disadvantaged backgrounds. The only study we found exploring differential teacher effect across socioeconomic groups concluded that teacher characteristics did not affect students' math attainment according to family income levels (Kukla-Acevedo, 2009). However, children from disadvantaged backgrounds end up in disadvantaged schools (Nechyba, 2006) and evidence suggests that children attending disadvantaged schools are more likely to be taught by unqualified or novice teachers (Clotfelter et al., 2006, 2010; Ramirez, 2006; Hill et al., 2019). Additionally, more experienced and qualified teachers tend to be located in more advantaged schools and classes, and this can exacerbate the inequality gap (Clotfelter et al., 2006, 2010; Hanushek and Rivkin, 2006; Ramirez, 2006; Hill et al., 2019). Exploring the importance of teacher characteristics on the attainment of students from disadvantaged backgrounds may provide insights on the role teacher deployment can play in mitigating the inequality gap.

Context of the Study

The current study examines the effect of selected teacher characteristics on students' educational attainment in Ghana. All public and private basic schools are under the supervision of the Ghana Education Service (GES) and are mandated to teach the national curriculum. Private schools form approximately a quarter of primary school education (Ministry of Education, 2016a). The recruitment, quantity and quality of teachers in public schools are determined by the government while for private schools, the owners and managers have the exclusive responsibility of the recruitment, quantity and quality of teachers.

All private basic schools are required by law to be registered with the Metropolitan, Municipal and District educational directorates within which they operate. In both types of schools, the practice is that one teacher is responsible for teaching all subjects in their class at any given time during an academic year. Available evidence indicates that teachers in public basic schools are randomly assigned to schools, classrooms, and pupils (Balwanz and Darvas, 2013). Teachers are not sorted and assigned to specific classrooms based on the characteristics of pupils (e.g., aptitude, IQ level, ability, and attainment) or teachers (e.g., ability, specialist area, academic qualification, and perceived effectiveness). However, there is evidence of sorting of students into schools due to parental influence on school choice. Most parents who can afford it send their children to private schools and good quality public schools are mostly attended by children from more advantaged background (Akaguri, 2011; Ministry of Education, 2016b). Primary school teachers were trained as

generalist teachers capable of teaching all subjects until 2017 when a new policy mandates teacher trainees to specialise in one of three levels - early grade, upper primary and junior high (Ministry of Education, 2017a,b).

Many children in Ghana, as in most low to middle-income countries, face significant challenges of equitable access to quality education (United Nations Educational, Scientific and Cultural Organisation, 2014; Ministry of Education, 2016a; Organisation for Economic Co-operation and Development, 2016; World Bank, 2018). For instance, the 2007 Trends in International Mathematics and Sciences Study (TIMSS) results show that only 1% of children in Ghana achieved the upper international benchmark of 550 points in Science, with over 80% not attaining the low international benchmark of 400. The trend was not different for Mathematics attainment (Martin et al., 2012). Further, data from the 2016 Ghana National Education Assessment (Ministry of Education, 2016b) indicates less than 25 and 40% of primary school children were proficient in Mathematics and English language, respectively. There are also significant inequalities in children's educational attainment in Ghana with children from more disadvantaged backgrounds or attending disadvantaged schools (e.g., low-income, rural, and public schools) performing well below those from more affluent backgrounds attending more advantaged schools (e.g., high income, urban, and private schools) (Varly et al., 2014; Chowa et al., 2015; Azigwe et al., 2016; Bashir et al., 2018). For instance, the 2011 TIMSS results indicate a higher proportion of children from wealthy backgrounds (34%) achieved minimum standards in science and Mathematics compared to those from poor backgrounds (16%). Additionally, the Ministry of Education (2016b) indicates significant gaps in English Language and Mathematics proficiency between children from urban (56 and 34%) and rural (24 and 18%) areas respectively.

In Ghana, the current policy focus is to prepare teachers with high levels of professional and academic qualifications in a bid to improve teacher quality (Ministry of Education, 2017a,b). This mirrors the global drive promoted through SDG 4 (United Nations, 2015). The assumption is that teachers with high academic and professional qualifications will lead to improved student attainment (Organisation for Economic Co-operation and Development, 2012; World Bank, 2018). However, existing literature from the Ghana context on the effect of these teacher factors on students' attainment is scarce, and results from the small number of studies we uncovered were mixed (e.g., Chowa et al., 2015; Azigwe et al., 2016). For instance, Chowa et al. (2015) found no association between the proportion of teachers with post-secondary qualifications and children's educational attainment. Additionally, there is no evidence as to whether these teacher characteristics equally help to close the socio-economic attainment gap. Given the limited evidence for the effect of these teacher characteristics in Ghana, the current study addresses the following questions:

- (1) To what extent are selected teacher characteristics (certification, experience, and academic qualification)

associated with primary school children's English Language and Mathematics attainment in Ghana?

- (2) Is the relationship between selected teacher characteristics and children's educational attainment moderated by school disadvantage status?

MATERIALS AND METHODS

Data and Sample

This study utilised the 2013 Ghana National Education Assessment (GNEA) data and administrative data on the demographic and service information of teachers who taught them during the 2012–2013 academic year. Secondary data were obtained following ethical approval from the various data owners. The GNEA data consists of primary 6 attainment data in Mathematics and English language tests, as well as information on gender, age, type of school attended and location. Each school, district and region from which students were sampled were identified by a unique school, district and region identity code. Stratified random sampling was used to select participating schools and students for the attainment data (see, Varly et al., 2014, for further details). According to the Ministry of Education (2013b) technical report, all scripts of participating students were duly returned ensuring a 100% return rate.

Teachers' demographic and professional information was provided by the Ghana Education Service. This data is based on a school census survey of all primary school teachers during the 2012/2013 academic year (Ghana Education Service, 2012; Ministry of Education, 2013a). This is a national exercise undertaken at the beginning of every academic year to collate and update teachers' information such as teachers' gender, years of experience, class taught, academic and professional qualifications. Data on teachers' demographic and professional information were requested for teachers who taught primary 6 students who participated in the GNEA assessment in 2012–2013 academic year at the specified schools. The data comprised teacher gender, teaching experience, academic and professional qualifications.

The current study drew on data from 6 out of the 10 regions in Ghana (prior to the creation of new regions in 2019) where both teacher and student attainment data were available to be linked. Out of the 10,492 grade 6 students from 275 (201 rural; 74 urban) schools in the six regions, information from 8,599 students from 250 (182 rural; 68 urban) schools were used for this study. Two main data exclusion criteria were applied to arrive at a final sample for schools and students. The first criterion was the exclusion of all schools that were not designated as rural or urban. This is because school locality was an important variable of interest for this study. A total of 53 unclassified schools comprising 1,668 students were deleted at this stage. This was followed by the deletion of information on 20 students with various forms of missing data. The second criterion was based on sample requirement guidelines for our chosen analytic procedure, multi-level modeling. As a result, all schools with less than 10 students in the class were excluded (see Hox et al., 2017). This

exercise led to the deletion of 25 schools (19 rural; 6 urban) comprising 205 students.

Data Merging Procedure

After applying the exclusion criteria and carefully dealing with missing information for the two separate datasets, a merging procedure was followed. Pupil attainment data were identified by a unique school level EMIS code (Ghana Education Service, 2012). Each teacher was also identified by the unique EMIS code of the school and the specific class they taught. This was because there was only one Primary 6 teacher who taught the class in the academic year of interest per school. Thus, the number of teachers ($n = 250$) was equivalent to the number of schools ($n = 250$). The two datasets (pupil and teacher) were linked by “matching cases by school code number.”

Measures

English Language and Mathematics Attainment

The dependent variables for the study are Mathematics and English language attainment scores for primary grade 6 students in a national assessment. Students were assessed using a 40-item test covering four domains for Mathematics (i.e., basic operations; collect and handle data; measurement and shape-space; numbers and numerals) and three domains for English language (grammar; listening; and reading). Both subject tests were scored on a scale of 0 to 40. According to the Ghana National Education Assessment Technical Report (Varly et al., 2014), the reliability indices of the test items using the Kuder–Richardson-20 (KR20) test were 0.89 for P6 Mathematics and 0.84 for P6 English language.

Teacher Characteristics

Three teacher characteristics (academic qualification, professional qualification, and experience) were examined in the current study.

Teachers' academic qualification

Teachers' academic qualification measured whether they were qualified with a university bachelors' degree and above regardless of the subject specialism and professional status (1) or had a non-degree qualification (0).

Professional qualification status

Teachers were classified as certified (1) or uncertified (0) depending on whether they held a qualification from any of the accredited teacher education institutions in the country. Certified teachers are those who possessed Certificates, Diplomas, Bachelor and Masters qualifications in Education. Uncertified teachers are all those without any professional certificate or degree in education.

Teaching experience

Teaching experience measured the number of years a teacher has been teaching regardless of their professional status and levels of education. In this study, the effect of teaching experience on academic attainment is measured at four levels: novice teachers (0–4 years); early career teachers (5–9 years); mid-career teachers (10–14 years); and experienced teachers (15 years and above).

This does not take into account the service history of teachers such as their experience of teaching at specific grade levels. The classifications were guided by prior studies which found different stages of teacher effectiveness with respect to teaching experience (e.g., Staiger and Rockoff, 2010; Rice, 2013; Toropova et al., 2019). In all analyses, the impact of teaching experience on attainment is assessed with reference to experienced teachers.

School Socioeconomic Disadvantage

Two school level indicators were used to measure school socioeconomic disadvantage. These were school location, and public or private status of the school.

School location

School location in the dataset was defined as either rural (0) or urban (1). In Ghana, localities that have more than 60% of residents engaged in non-agricultural activities and have a minimum population size of 5,000 are classified as urban (Ghana Statistical Service, 2012). Those localities which do not meet these criteria are classified as rural. Compared with urban localities, rural communities in Ghana often lack basic educational resources. Parents of rural school students are predominantly subsistence farmers and are characterized by high levels of poverty and low levels of literacy (Ghana Statistical Service, 2012). Some rural children have to walk long distances to get to their schools, and most rural schools lack basic teaching and learning resources (Ministry of Education, 2016a).

School type

This measured whether schools were privately (1) or publicly owned (0). Private primary schools are those owned, managed and financed by private individuals, entrepreneurs and faith-based bodies. The recruitment, teachers' conditions of service, and administration of these schools are entirely the responsibility of the managers of the school. Public primary schools are those funded, managed and run by the state. The recruitment and conditions of service of teachers are determined by the state. For the most part, students from socioeconomically advantaged backgrounds attend private primary schools. In Ghana, private schools are usually located in urban areas (Ministry of Education, 2016a). The dataset used for this study showed that the ratio of public to private schools in rural locations is 5:1.

Covariates

Several covariates were included in our analysis. These include class size ($M = 50.0$; $SD = 28.1$), pupil age ($M = 13.5$; $SD = 1.6$), gender of students (*Male* = 51.5%; *Female* = 48.5%) and gender of teachers (*Male* = 57.1%; *Female* = 42.9%).

Data Analysis

Data were analyzed using a multilevel modeling approach to account for clustering in our data set. Specifically, the approach allowed us to account for differences between children attending the same schools and not to overestimate the effects of teacher characteristics on children's attainment. Two-level hierarchical modeling was applied at pupil and school/teacher levels with the focus of the study being on level two (teacher) factors. As indicated earlier in the methodology section, teachers and schools

are treated as the same level in the analysis because only one teacher was sampled for a class in each school. In other words, only one teacher was nested in a particular grade in a school hence we do not decouple teacher level from school level. All independent and dependent variables were grand mean centered (Hox et al., 2017). The grand mean centered attainment score for each pupil is the difference between a pupil's raw score and the grand mean attainment score derived from all students regardless of any differences such as the types and location of the schools students attended. Grand mean centering ensured that the variances of the intercept and the slopes in the regression have a clear interpretation when all explanatory variables are equal to zero (Hox et al., 2017). Our analysis followed several simultaneous stages.

At the first stage, an unconditional baseline model with no predictors was specified to compute the Intra-class Correlation Coefficient (ICC). The ICC is the proportion of variance that is accounted for by group level clusters in the data and helps to determine whether MLM is required (Tolmie et al., 2011; Snijders and Bosker, 2012). The unconditional model also makes it possible for assessing improvements in subsequent models by comparing the initial deviance ($-2 \text{ Log Likelihood} [-2LL]$) of the null model to subsequent conditional models (Heck et al., 2011; Snijders and Bosker, 2012).

At stage two, four control variables (students' gender and age, teachers' gender and class size) were added as covariates to account for their possible confounding effects on children's educational attainment. The third stage of the analysis was the introduction of school disadvantage measures, that is, school type (private vs. public), and school location (rural vs. urban) into the model to estimate their impact on students' attainment. This was followed by an evaluation of the impact of three specific teacher characteristics (i.e., educational level, professional status, and teaching experience) at stage four. The final stage involved multi-group analysis to find out whether some teacher characteristics mattered more for the attainment of children attending disadvantaged schools (rural schools and public schools). Analyses were undertaken using sample weights (see Varly et al., 2014).

RESULTS

Descriptive Results

The descriptive information of teacher, pupil and other background characteristics by the measures of school socioeconomic disadvantage are presented in **Table 1**. There was a higher proportion of teachers with a minimum of bachelor's degree located in urban (70.6%) than rural schools (45.6%). Private schools had a higher share of teachers with degree qualifications (56.6%) than public schools (51.3%). Majority of the teachers in public schools (68.5%) held professional teaching qualifications compared to those in private schools (30.2%). The percentage of uncertified teachers was much higher in rural schools (45%) than urban schools (25%). Teaching experience ranged from 1 to 32 years, with an average teaching experience of 8.4 and 6.0 years for public and private school

teachers, respectively. The average teaching experience of teachers in urban schools was higher (9.4 years) than those in rural schools (7.3 years).

Prior to multivariate analysis, we undertook attrition analysis by comparing excluded and retained data to examine whether there were any significant differences on key predictor and outcome variables. There was no statistically significant differences between the samples on students' Mathematics attainment [$t(10490) = 0.53, p = 0.60$], teacher experience [$t(10490) = -0.28, p = 0.78$] or certification [$\chi^2(1, n = 10492) = 0.12, p = 0.73$]. Significant differences were observed for English language [$t(10490) = 4.11, p < 0.001$, two tailed] and educational qualifications [$\chi^2(1, n = 10492) = 9.05, p < 0.001$]. However, these differences were generally small suggesting data attrition is likely to have no impact on our estimates.

Inferential Results

The unconditional models for English language and Mathematics attainment (model 0, **Table 2**) indicate significant variations in students' attainment within and between schools thereby supporting the application of multilevel approach to analyzing the data. Respectively, 53.7 and 46.3% of English language attainment differences were within and between schools, while 65.1 and 34.9% of Mathematics attainment differences were within and between schools.

The coefficient estimates of all variables with their respective standard errors (in brackets) are presented in **Table 2**. Results from the final model (model 1, **Table 2**) show that *school socio-economic characteristics* (school location and school type) accounted for statistically significant differences in children's English language and Mathematics attainment. Children from rural ($b = -4.43, p < 0.001$) and public schools ($b = -8.92, p < 0.001$) achieved significantly lower grades in English language. Similarly, children in rural ($b = -1.40, p < 0.001$) and public schools ($b = -4.19, p < 0.001$) recorded lower levels of attainment in Mathematics than their peers in urban and private schools.

Findings on *teacher characteristics* showed that whether children were taught by certified or uncertified teachers significantly influenced their academic attainment. Students taught by uncertified teachers on average, achieved lower grades in English language ($b = -1.71, p < 0.01$) and Mathematics ($b = -0.92, p < 0.01$) than those taught by certified teachers. The overall association of teaching experience with attainment was generally linear during the early years of teaching but appears to plateau out over time. For English language, students taught by teachers with 15 years of experience and above attained better grades than those whose teachers had only 1–4 years of experience ($b = -3.21, p < 0.001$), and 5–9 years of experience ($b = -2.27, p < 0.01$). However, attainment was not significantly different for students whose teachers had 10–14 years of experience. With respect to attainment in Mathematics, students taught by experienced teachers (15 years and above) attained higher grades than those taught by teachers with 1–4 years of experience ($b = -1.49, p < 0.01$). However, student attainment was not statistically different for those whose teachers had 5–9 or 10–14 years of experience suggesting that the

TABLE 1 | Distribution of students and teachers' characteristics by school socioeconomic indicators.

Variables	Over all	School location		School type	
		Rural	Urban	Public	Private
Teacher academic qualification					
Degree	131 (52.4%)	83 (45.6%)	48 (70.6%)	101 (51.3%)	30 (56.6%)
Non-degree	119 (47.6%)	99 (54.4%)	20 (29.4%)	96 (48.7%)	23 (43.4%)
Teacher professional qualification					
Certified	151 (60.4%)	100 (54.9%)	51 (75.0%)	135 (68.5%)	16 (30.2%)
Uncertified	99 (39.6%)	82 (45.1%)	17 (25.0%)	62 (31.5%)	37 (69.8%)
Teaching experience					
Novice (0–4 years)	2966 (34.5%)	2167 (38.2%)	799 (27.3%)	2360 (33.3%)	606 (40.2%)
Early career (5–9 years)	3035 (35.3%)	2029 (35.7%)	1006 (34.4%)	2331 (32.9%)	704 (46.7%)
Mid-career (10–14 years)	1681 (19.5%)	1078 (19.0%)	603 (20.6%)	1500 (21.2%)	181 (12.0%)
Experienced (≥ 15 years)	917 (10.7%)	403 (7.1%)	514 (17.6%)	899 (12.7%)	18 (1.2%)
Class size ¹	50	46	58	51	45
Pupil age ¹	13.4	13.7	13.2	13.8	12.4
Number of schools	250	182	68	197	53
Sample size	8,599	5,677	2,922	7,090	1,509
Teacher gender					
Male	147 (58.8%)	105 (57.7%)	42 (61.8%)	117 (59.4%)	30 (56.6%)
Female	103 (41.2%)	77 (42.3%)	26 (38.2%)	80 (40.6%)	23 (43.4%)
Pupil gender					
Male	4426 (51.5%)	2954 (52.0%)	1472 (50.4%)	3687 (52%)	739 (49%)
Female	4173 (48.5%)	2723 (48.0%)	1450 (49.6%)	3403 (48%)	770 (51%)

NB, ¹Represent average (mean) values.

importance of experience plateaus earlier for Mathematics. There was no significant difference in attainment scores of children who were taught by teachers with a minimum of bachelors' degree and those with qualifications below a degree. Findings of the covariates indicate that students' gender and age as well as class size were significantly associated with attainment in both subjects.

Multi-Group Analysis: Exploring Differential Teacher Effects

Findings exploring the differential impact of teacher characteristics (Table 3) indicate that *teacher certification* was uniquely associated with attainment of students attending disadvantaged (rural and public) schools for both subjects. Specifically, children in *rural schools* who were taught by uncertificated teachers had significantly lower grades in English language ($b = -1.79, p < 0.01$) and Mathematics ($b = -0.93, p < 0.01$) compared to rural peers who were taught by certificated teachers. Similarly, children in *public schools* who were taught by uncertificated teachers had significantly lower grades in English language ($b = -2.21, p < 0.01$) and Mathematics ($b = -0.97, p < 0.01$) compared to public peers who were taught by certificated teachers. However, certification was not statistically associated with attainment of students attending *urban or private schools* in both subjects. Figure 1 illustrates predicted average scores for children taught by certified and uncertified teachers in different categories of schools.

The extent to which *teacher experience* was uniquely associated with attainment of children attending disadvantaged (rural and public) schools was mixed. Teaching experience was equally

important for the attainment of children in both *rural and urban schools*. For English language, students taught by novice teachers with up to 4 years of experience obtained lower grades (rural: $b = -2.45, p < 0.05$; urban: $b = -5.56, p < 0.01$) than students taught by teachers with 15 years and above of experience. Similar patterns were observed for Mathematics (rural: $b = -1.25, p < 0.05$; urban: $b = -2.74, p < 0.01$) with the difference in attainment between novice and experienced teachers appearing to be greater in urban than rural schools. However, the importance of experience plateaus from the fifth year with no statistically significant difference in attainment between students taught by teachers with 15 years and above, 10–14 years, or 5–9 years of experience.

With respect to attainment of students attending private versus public schools, the findings show that *teaching experience* was uniquely associated with attainment of students in public but not private schools. For English language, students in *public schools* taught by teachers with > 15 years of experience obtained higher scores than peers taught by novice teachers with up to 4 years of experience ($b = -3.05, p > 0.05$) and 5–9 years of experience ($b = -2.21, p < 0.05$). This difference appears to plateau from the 10 years of experience. For Mathematics, students in public schools taught by teachers with > 15 years of teaching experience obtained higher scores than peers taught by novice teachers with up to 4 years of experience ($b = -1.547, p > 0.05$). There was, however, no difference between attainment of students taught by the experienced group and teachers with more than 5 years of experience suggesting an early plateau. Teaching experience was not associated with attainment in English language or Mathematics in *private schools*.

TABLE 2 | Association between teacher, school deprivation characteristics and students' attainment.

	English language		Mathematics	
	Model 0 Coeff. (SE)	Model 1 Coeff. (SE)	Model 0 Coeff. (SE)	Model 1 Coeff. (SE)
Intercept	-0.72 (0.40)	12.31 (1.14)	-0.28 (0.19)	4.96 (0.63)
Within variance controls				
Pupil gender (male)		0.53 (0.13)***		0.57 (0.09)***
Pupil age		-0.71 (0.05)***		-0.30 (0.03)***
Between variance				
Teacher characteristics				
Professional certification (uncertified)		-1.71 (0.58)**		-0.92 (0.32)**
Academic qualification (non-degree)		0.69 (0.53)		0.27 (0.30)
Teaching experience				
Novice (0–4 years)		-3.21 (0.99)***		-1.49 (0.55)**
Early career (5–9 years)		-2.27 (0.94)*		-0.88 (0.52)
Mid-career (10–14 years)		-0.40 (1.01)		-0.34 (0.55)
Experienced (≥ 15 years): reference		-		-
School deprivation				
School type (public)		-8.92 (0.72)***		-4.19 (0.40)***
School location (rural)		-4.43 (0.60)***		-1.40 (0.36)***
Controls				
Class size		0.05 (0.01)***		0.02 (0.01)***
Teacher gender (male)		-0.06 (0.53)		0.37 (0.29)
Variance component				
Pupil (%)	53.7	68.6	65.1	77.0
School (%)	46.3	31.4	34.9	23.0
-2LL (deviance)	55560	55127	49054	48799
Change in deviance (-2LL)	-	195	-	132
χ^2	-	24.7	-	24.7
df	-	11	-	11
p-value	*	***	*	***

*** $p < 0.0001$, ** $p < 0.01$, * $p < 0.05$. Coeff, coefficient; SE, standard error.

DISCUSSION

This study examined (i) the association between teacher characteristics and children's educational outcomes and (ii) whether certain teacher credentials matter more for children attending disadvantaged schools. Our findings indicate that a significant proportion of differences in children's educational attainment resulted from differences between schools. We also found that some of these between-school differences are related to specific characteristics of teachers in the schools.

Specifically, teacher certification and experience were significantly associated with higher scores in primary school children's educational attainment in English language and Mathematics. Similar findings on the positive effects of teacher certification and experience on children's attainment have been reported in recent studies from high income countries (Bhai and Horoi, 2019; Podolsky et al., 2019; Toropova et al., 2019). Thus, our result provides the much needed evidence of teacher effectiveness from low to middle-income countries to complement existing knowledge mainly derived from research

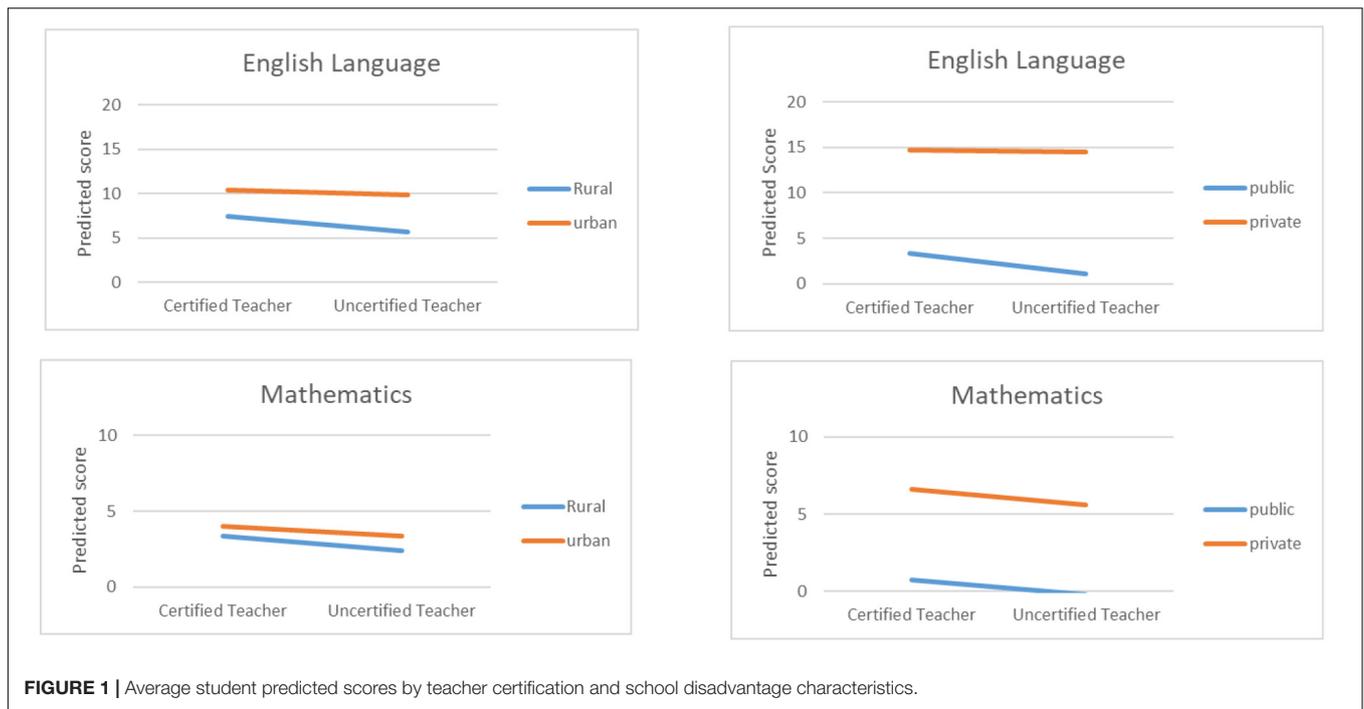
in high-income countries. Importantly, it highlights the need for staffing schools with certified teachers to achieve quality education for all, especially in low and middle-income countries where a large proportion of children do not have access to certified teachers (United Nations Educational, Scientific and Cultural Organisation, 2019). Generally, students taught by more experienced teachers (i.e., those with a minimum of 15 years) obtained higher grades than peers taught by novice teachers. However, consistent with previous findings (e.g., Toropova et al., 2019) the advantage of teacher experience appears to plateau by the fifth year for Mathematics and tenth year for English language. This suggests that the extent to which teacher experience influences students educational attainment may depend on the subject of interest. In other words, novice teachers are able to catch up with their more experienced peers after a short number of years of experience in some subjects than in others.

The findings on teacher experience suggest that beginning or less experienced teachers may benefit from support to develop the essential knowledge and skills that more experienced

TABLE 3 | Multi-group analysis: exploring differential teacher effects with respective standard errors (SE) in brackets.

	English language				Mathematics			
	Rural Coeff. (SE)	Urban Coeff. (SE)	Public Coeff. (SE)	Private Coeff. (SE)	Rural Coeff. (SE)	Urban Coeff. (SE)	Public Coeff. (SE)	Private Coeff. (SE)
Intercept	7.48 (1.38)	10.40 (2.39)	3.32 (0.96)	14.75 (4.44)	3.39 (0.79)	4.03 (1.22)	0.76 (0.51)	6.47 (2.84)
Within variance								
Pupil gender (male)	0.63 (0.15)***	0.34 (0.23)	0.49 (0.14)	0.76 (0.30)***	0.64 (0.11)***	0.44 (0.16)**	0.61 (0.09)***	0.38 (0.24)
Pupil age	-0.49 (0.06)***	-1.30 (0.10)***	-0.65 (0.05)***	-1.33 (0.16)***	-0.18 (0.04)***	-0.59 (0.07)***	-0.25 (0.03)***	-0.71 (0.13)***
Between variance								
Teacher characteristics								
Prof qual (uncertified)	-1.79 (0.58)**	-0.55 (1.91)	-2.21 (0.66)***	-0.24 (1.26)	-0.93 (0.33)**	-0.65 (0.98)	-0.97 (0.35)**	-1.04 (0.80)
Acad qual (non-degree)	0.74 (0.56)	0.84 (1.24)	0.91 (0.57)	0.06 (1.23)	0.25 (0.32)	0.55 (0.64)	0.30 (0.30)	0.31 (0.78)
Teacher experience								
Novice (0–4 years)	-2.45 (1.11)*	-5.56 (2.01)**	-3.24 (0.99)***	-6.76 (4.41)	-1.25 (0.6)*	-2.74 (1.01)**	-1.55 (0.53)**	-3.48 (2.82)
Early career (5–9 years)	-2.02 (1.08)	-2.04 (1.84)	-2.21 (0.94)*	-6.38 (4.21)	-0.98 (0.61)	-0.28 (0.93)	-0.92 (0.50)	-2.16 (2.70)
Mid-career (10–14 years)	-0.65 (1.15)	1.15 (1.89)	0.44 (1.01)	-7.13 (4.39)	-0.77 (0.66)	1.11 (0.96)	-0.05 (0.53)	-3.05 (2.81)
Experienced (≥15 years)	–	–	–	–	–	–	–	–
School deprivation								
School type (public)	-9.13 (0.80)***	-7.58 (1.75)**	n/a	n/a	-4.13 (0.46)***	-4.08 (0.90)***	n/a	n/a
School location (rural)	n/a	n/a	-4.54 (0.74)***	-2.81 (1.30)*	n/a	n/a	-1.45 (0.39)***	-0.60 (0.83)
Controls								
Class size	0.04 (0.01)**	0.09 (0.03)***	0.04 (0.01)**	0.11 (0.03)***	0.02 (0.01)*	0.05 (0.01)***	0.01 (0.01)*	0.07 (0.02)***
Teacher gender (male)	-0.08 (0.58)	1.20 (1.14)	-0.36 (0.57)	1.05 (1.15)	0.37 (0.33)	1.14 (0.58)*	0.14 (0.30)	1.12 (0.73)
Variance component								
Pupil (%)	71.3	66.7	70.4	69.8	79.2	80.8	80.1	80.2
School (%)	28.7	33.3	29.6	30.2	20.8	19.2	19.9	19.8

*** $p < 0.0001$, ** $p < 0.01$, * $p < 0.05$. Coeff, coefficient; SE, standard error.



teachers deploy (Robson and Mtika, 2017; Wolff et al., 2017; Podolsky et al., 2019). It may be that existing certified and experienced teachers are implored to serve as mentors to newly qualified teachers. This will require formally recognizing the role of mentors in schools and creating the structure within the educational system for this type of support.

Findings on the association between teacher academic qualification and children's educational outcomes were in line with prior studies that show no relationship between teachers holding higher academic degrees and children's attainment (Clotfelter et al., 2010; Chowa et al., 2015; Bhai and Horoi, 2019). This further underscores the need for ensuring that all teachers, irrespective of their level of academic qualification, have the necessary teacher professional qualification to enable them successfully improve learning outcomes for all learners.

With regards to educational inequality, we found significant differences in educational attainment between children attending advantaged and disadvantaged schools. More specifically, children who attend schools in urban areas and private schools obtained higher grades compared to their peers in rural and public schools. Similar to other findings from Ghana (Chowa et al., 2015; Azigwe et al., 2016), our results indicate that the well-known poverty related attainment gap is starkly represented by differences between schools. A key contributory factor may be the deliberate selection of children and teachers to more advantaged schools. While there is no policy in Ghana that deliberately assigns teachers and students into different schools at the primary school level, parents from advantaged backgrounds can exercise a greater level of choice by sending their children to private schools, for example. Predominantly, most disadvantaged children have no choice but attend disadvantaged schools with poor teaching and learning resources, and where teachers are

less likely to be experienced or certificated (Clotfelter et al., 2006, 2010; Hill et al., 2019). The evidence for selection of children from wealthy households into advantaged schools was represented by differences in educational attainment between public and private schools which are socioeconomically stratified.

Consistent with previous studies (e.g., Clotfelter et al., 2006, 2010; Hanushek and Rivkin, 2006; Hill et al., 2019), we found evidence for teacher sorting with certified and more experienced teachers working in urban public than rural public schools. The exception to this rule in our study is the greater proportion of certified teachers in public schools compared to private schools. The evidence that private schools with less certified teachers outperform public schools raises questions about the importance of these teacher characteristics. However, further analysis indicates that these teacher characteristics are particularly important for the attainment of children attending public disadvantaged schools. In other words, different factors such as children's own socioeconomic backgrounds may be the predominant factor influencing the attainment of children in private schools while teacher characteristics is an important factor for the attainment of children attending disadvantaged schools. Consequently, the key factor to moderate the association between school disadvantage and educational attainment is to have certified teachers and teachers with certain levels of teaching experience.

Our findings indicating inequality in educational attainment associated with attending disadvantaged schools require urgent attention. Policies that focus on addressing inequality are needed as Ghana moves toward a middle-income status. This is because educational inequality associated with poverty tends to exacerbate as countries become more economically developed (Kim et al., 2019). We argue that, in the quest to mitigate

academic inequality gaps, rural and deprived schools need to be provided with the necessary educational resources to enhance teaching and learning. This includes the deployment of certified teachers with appropriate levels of experience to teach learners at all grade levels and school subjects.

The importance of teacher characteristics for children's educational attainment was demonstrated by the greater association between the selected teacher credentials on the attainment of children attending advantaged as opposed to disadvantaged schools. We found that teacher certification explained differences in the attainment of children in rural (for both Mathematics and English language) but not urban schools, with rural school-children who were taught by certified teachers obtaining higher grades than their peers taught by uncertified teachers. Additionally, teacher certification and experience accounted for differences in attainment between children attending public but not private schools. A child who attends a public school and is taught by a certified and experienced teacher obtained higher grades than their peer who was taught by an uncertified and less experienced teacher. This suggests that teacher certification and experience are more important for the attainment of children attending disadvantaged schools.

It can be argued that for children attending more advantaged schools, differences in attainment may be attributed to family and other sociodemographic characteristics. The findings provide novel evidence from a lower-middle-income context in support of the argument that children from disadvantaged backgrounds are more likely to benefit from good quality teaching. Our results have the potential to stimulate policy discussion on measures for mitigating the learning outcomes' gap between rural and urban schools as well as public and private schools. Thus, to address the educational inequality gap, measures to deploy certified and more experienced teachers to rural schools need to be formulated, given that rural schools tend to be unattractive to many certified teachers (Bashir et al., 2018).

Our findings should be interpreted in light of the following caveat. First, care is needed in drawing any causal relationship between the selected teacher credentials and children attainment due to the cross-sectional nature of our data. However, the consistency between our findings and those employing value-added methods and twin studies (e.g., Bhai and Horoi, 2019) add to the growing evidence of the importance of these teacher characteristics to children's educational attainment. Second, we relied on proxy measures of school disadvantage, which is likely to underestimate the actual differences between advantaged and disadvantaged schools. Future studies using more complex measures of school disadvantage may help determine the magnitude of school-disadvantage effect. Third, due to absence of child level characteristic data, our study is unable to explain the array of child related factors that are known to be associated with educational attainment. Fourth, the non-random distribution of students to teachers may be another possible confounding factor in the study. Unfortunately, children's prior attainment data was not available to account for this in our analysis. Fifth, we can only speculate on why teacher certification and experience are associated with positive educational attainment. Future research

examining how these characteristics translate to differences in actual classroom practice is required to help inform professional development activities for all teachers. Finally, our paper is based on data from 2013 which was the most comprehensive national attainment data on primary school children at the time of conceptualizing the study. Since then, there has been only one additional national assessment in 2016 (Ministry of Education, 2016b). A comparison of the 2013 and 2016 data indicates very minimal changes in pupil attainment. For instance, the proportion of primary grade 6 children meeting the minimum proficiency in English language was 39% in 2013 and 38% in 2016. Disparities between pupils attending disadvantaged and more advantaged schools were equally consistent. For instance, the minimum proficiency levels in English language for primary grade 6 children in urban areas was 59% (2013) and 56% (2016), respectively, while that for rural pupils were 27% (2013) and 27% (2016), respectively. Similar trends were observed for attainment between children attending public and private schools.

Implications for Policy and Practice

As already discussed the current study has significant implications for policy and practice. First, it is recommended that educational stakeholders take steps to train more certified teachers and deploy these to all primary schools, particularly rural disadvantaged schools. Second, uncertified teachers should be supported to undergo upgrading courses through existing systems of teacher education. Third, greater opportunities for continuous professional development and mentorship should be provided especially to uncertified and early career teachers to help improve their teaching competence. Fourth, more highly qualified teachers should be encouraged through policy incentives to teach in rural schools. Finally, addressing the causes of educational inequalities and establishing mechanisms for monitoring improvements in educational outcomes for children from different socioeconomic background should be central to government policy.

CONCLUSION

There are significant implications arising from this study for governments in low to middle-income contexts in their efforts toward equitable access to quality education for all. The results from this study are helpful in the formulation of teacher deployment policies that allocate certified and more experienced teachers to schools with students from disadvantaged backgrounds. There are many primary schools in low and middle-income countries that are not staffed with certified teachers, which undermines the quality of learning experiences and outcomes for these children. The challenge is that a majority of the certified and experienced teachers are mostly working in urban and advantaged schools. There should therefore be bold efforts to train more certified teachers and deploy these to all primary schools, particularly rural disadvantaged schools. There is also the need for policies that encourages experienced teachers to teach in rural schools. In the

short term, uncertified teachers should be supported to undergo upgrading courses through existing systems of teacher education and through the creation of innovative continuous professional development programs.

DATA AVAILABILITY STATEMENT

The original datasets can be obtained from the data holders. We only have permission to use the data for our research.

AUTHOR CONTRIBUTIONS

MN, ES, PM, and DR contributed to the conceptualization of the study. MN screened and organized the data and wrote the first draft of the manuscript with significant inputs from ES and PM. MN and ES undertook data analysis. MN, ES, and PM

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