

Black Girls as Learners and Doers of Science: A Single-Group Summary of Elementary Science Achievement

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Abstract

Black girls represent a unique subpopulation of science learners. Black girls are unique because they consistently outperform Black boys in science. Despite this trend, Black girls often face dual marginalization in STEM classrooms and professions. Racial and gender marginalization can inhibit the success of Black girls in science if researchers, teachers and parents do not address the most salient factors. This exploratory analysis investigates how the specialized science content knowledge of Black girls is differentiated on the NAEP and how the dispositions, opportunities to learn, and parental involvement mechanisms are characterized by the NAEP assessment data. This within-group, content-specific analysis identifies teaching and learning strengths and weaknesses for Black girls that are difficult to assess using between-group designs. This study offers educators, researchers, and parents a holistic view of the performance profile of Black girls, as learners and doers of science. The results indicate that Black girls possess a basic understanding in life and physical sciences, however earth science remains the greatest challenge. Overall, the data shows that Black girls have a positive academic disposition towards science, yet are not engaged with the content. Recommendations for researchers, teachers, parents and other educational stakeholders to further meet the needs of Black girls in science are provided.

Keywords: Black girls, science, NAEP, STEM, achievement, elementary

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Introduction

Success in Science, Technology, Engineering, and Mathematics (STEM) is highly contingent upon student proficiency in science. According to the National Research Council (NRC) (2012), science is a critical component of a student's educational experience, and essential for understanding and addressing many of society's most pressing current and future challenges. Given the significance of scientific inquiry, all students should experience an education that affords them the opportunity to explore careers in science related fields. Unfortunately, data suggest that female science career

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aspirations vary according to the students' gender and racial background (Catsambis, 1995). Black girls represent a unique population of STEM learners that can potentially contribute to the future STEM workforce if educators and parents can maximize their academic potential in science.

The underrepresentation of Black women in science-related careers is a serious concern, especially given that Black girls, are dually marginalized by their race and gender (Hubbard, 2005; Morris, 2007; Rollock, 2007; West-Olatunji et al., 2010). The current literature lacks examination of the academic achievement profiles of Black girls on specific science content domains. These achievement profiles would allow researchers to develop prescriptive interventions that can guide content-based instructional practices tailored to close science “knowledge gaps” and eliminate the need to exclusively investigate “achievement gaps.”

Much of the available research utilizes between-group designs involving Black and White students or boys and girls. One major limitation of racial or gender comparative designs, however, is that when group differences are found, investigators are left to speculate on the cause of those differences (Martin, Mullis, Foy, & Stanco, 2012; Provasnik et al., 2012). These activities perpetuate the trend of “gap gazing” or an overemphasis on examining achievement gaps (Gutiérrez, 2008; Lubienski, 2008; Young & Young, 2016). These activities fail to yield information that is practically significant for educational use. Homogeneous, within group, content-oriented designs could allow researchers to identify sources of achievement differences between groups by pinpointing content specific knowledge gaps. Therefore, the purpose of this study is to utilize a gender-specific, ethnically homogeneous design to summarize the science achievement of Black girls in an educational and familial context. This study is important because a single-group summary of the early achievement of Black girls in science remains elusive. Furthermore, this study characterizes school and environmental educative factors that can afford and constrain the development of Black girls as successful learners and doers of science.

Black Girls as Learners and Doers of Science

Traditionally, Black student achievement is investigated through between-group gap analysis, which provides information on racial differences in achievement, but fails to elicit pedagogically meaningful information to inform instructional praxis. White students consistently outperformed Black students in elementary science assessments (National Center for Education Statistics [NCES], 2015). For example, National Assessment of Educational Progress (NAEP) 2005 science scores indicate that only 18% of fourth-grade White students score below basic, but a staggering 62% of fourth-grade Black students score below basic proficiency in science (Grigg, Lauko, & Brockway, 2006). Additionally, based on national early science achievement trends, Black children are at greater risk than their White counterparts of falling behind (Pringle, Brkich, Adams, West-Olatunii, & Archer-Banks, 2012). Subsequently, many Black students failed to make up these gaps and consequently those who do enter STEM professions do so with less science content knowledge than their peers. Alternatives to between-group analyses are available, but not widely accepted.

Between-group analysis although necessary, can create perceptions of habitual underachievement in teachers and leaders serving students of color. This information has scholarly merit, but from an instructional standpoint one can only assume that more attention should be

placed on Black student science content knowledge. Specific gaps in Black student science content knowledge are masked in the presentation and concentration on racial and gender differences, rather than specific student performance on content strands or domains.

Underachievement among low-income Black girls remains a challenge when compared with their white counterparts (Corbett, Hill, & St. Rose, 2008). However, three factors are consistently cited as antecedents to Black girl achievement: (1) dispositions (Acker & Oatley, 1993; Packard & Nguyen, 2003), (2) opportunities to learn (Harley, Jolivet, McCormick, & Tice, 2002), and (3) parental involvement (Taylor, Hinton, & Wilson, 1995). Despite historical trends of underachievement perpetuated through gap analysis, Black girls hold a unique capacity to be productive members of the scientific community. The educative affordances and constraints of scientific dispositions, opportunities to learn, and parental support are examined in the following sections.

Scientific Dispositions

The development of “self” is an essential element in the development of Black girls as learners and doers of science. These perceptions influence how Black girls position themselves in the science classroom. According to Fordham (1993) navigating the culture of science, which is significantly different from Black culture, can cause distress and serve to alienate Black girls from science. The early development of a strong science identity can help mediate academic distress and build agency and resilience in Black girls. Based on work with third grade students in an urban setting, Kane (2011) posited that Black students’ constructions of “self” in science classrooms are shaped by three components of science identity: (1) competence, (2) performance, and (3) recognition. Hence, it is imperative that Black girls possess science competence that is evident in performance and recognized in the classroom. The ideas that individuals use to construct an understanding of the world and their perception of the position they occupy within this construed reality are key premises of positionality (Parsons, 2008, p. 1129), which extends into all areas of the human experience including interactions between teachers and learners in the science classroom. If Black girls have a positive self-concept then they will not allow negative classroom interactions to permanently imprint on their perceptions of themselves as learners of science, and likewise positive classroom interactions will supplant the negative. Furthermore, early development of self-concept in women and students of color enhances their self-efficacy, which successively cultivates science achievement (Leslie, McClure, & Oaxaca, 1998).

Self-concept is perception of self, while self-efficacy is belief in one's ability to perform a given behavior (Lent, Lopez, & Bieschke, 1991). These constructs share a symbiotic relationship that yields substantial benefits for all learners across content areas, but the science classroom benefits of increased self-efficacy for Black girls are numerous. According to Koballa and Glynn (2007) students who have high self-efficacy in science tend to set higher goals, persist longer, expend greater effort, and endeavor to find increasingly better strategies. Thus, when Black girls’ self-concept and subsequent self-efficacy are developed they can begin to position themselves favorably in the science classroom, because they feel more confident as a member of the scientific community. Their science content knowledge is also affirmed, which enables them to participate fully in the classroom. Classroom interactions are an important consideration, when examining the achievement of Black girls in science. Many of these interactions are either afforded or constrained by opportunities to learn.

Opportunities to Learn Science

Interactions with teachers and curriculum can influence the ability of Black girls to view themselves as learners and doers of science. Science classroom interactions are important mediators of Black girl attitudes and achievement in science. Because a Black girl's attitude towards science predicts future course-selection patterns and ultimately their achievement in science, positive classroom interactions are crucial (Weinburgh & Steele, 2000). Oftentimes classroom interactions are differentiated by the quality of the pedagogical practices and school resources related to science instruction. Many of these interactions can be characterized as opportunities to learn.

Research suggests that school related factors such as teacher quality, rigorous curriculum, student academic engagement, and high expectations are commonly cited as opportunities to learn that are absent from many classrooms serving large populations of culturally and linguistically diverse students (Delpit, 2012; Boykin & Noguera, 2011). For example, research on teaching and learning suggests that many students of color receive instruction in schools that lack instructional resources, which creates an environment where pedagogical decisions are driven by factors such as the classroom management and arduous high-stake test preparation (Pringle & Martin, 2005; Traynor, 2003). When learning is absolved as the driving force of a school, opportunities to learn become absent as well. Teacher experience and qualifications are also consistently differentiated by school racial and socio-economic composition (Darling-Hammond, 2010; Howard, 2010).

Teaching experience generally allows teachers to become more effective with additional years of experience. Novice teachers (those with two or fewer years of experience) are most commonly found in low-income schools and schools with the highest percentage of non-Asian minority students (National Science Board, 2014). In regards to college-level science courses taken by elementary science teachers, the National Science Teachers Association (NSTA) suggests that each elementary teacher take one course in life, earth, and physical sciences (Banilower et al., 2013). In 2012 only 36% of elementary teachers met this standard (National Science Board, 2014). Additionally, elementary teachers are generally less prepared to teach science compared to the other content areas. The National Science Board (2014) reported that elementary science teachers' confidence in teaching mathematics eclipses that of science with 77% feeling prepared for mathematics instruction and only 39% feeling prepared to teach science. Within science content, teachers felt more confident to teach life and earth science than physical science topics. Nonetheless, many school serving large populations of Black girls lack the resources to remediate these and other teacher knowledge gaps.

Unfortunately, due to the many fiscal and environmental constraints placed on these schools, resources are not utilized to build the instructional capacity of teachers. Therefore, many teachers do not receive advanced or continuing science content and pedagogical coursework. Furthermore, many teachers do not receive subject specific training to make science instruction more accessible and engaging to diverse populations of students. Given this reality, a major challenge for teachers of Black girls can be integrating intellectually powerful forms of argumentation, elucidation, narration, representation, and imagination across linguistic, visual, bodily, emotive, and symbolic modes of explanation common to the lives of Black students into the science curriculum. The lack of specialized science content knowledge, as well as the absence

of continuing professional development, impedes opportunities for creating culturally responsive science instruction.

Learning is a cognitive, emotional, personal, social, and cultural experience for each student (Brickhouse, Lowery, & Schultz, 2000), thus, in order for science instruction to resonate with Black girls, science should be connected to their interests, prior knowledge, and abilities (Seiler, 2001). All children have unique cultural funds of knowledge that they bring to the classroom that must be affirmed and utilized as conduits to learning. Funds of knowledge are defined as ‘historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being’ (Gonzalez, Moll, & Amanti, 2005, p. 133). Thus, it is argued here that when teachers incorporate these funds of knowledge through culturally responsive teaching, Black girls’ experiential knowledge can be used as an instructional asset. Unfortunately, the absence of culturally responsive teaching practices can create a cultural discontinuity between home, school, and the science content for many Black girls (Cholewa & West-Olatunji, 2008; Hale, 2001; King, 2004). This disconnection between their communal environments and school can create barriers to achievement and engagement in science learning for Black Girls. Some argue that this discontinuity is the result of a “cultural deficit”, or that the student lacks the cultural capital to engage in the classroom activities. However, when teachers fail to build bridges between their students’ prior knowledge and the instructional content, we argue that this is more reflective of an “instructional deficit”. Although opportunities to learn have a direct influence on the science achievement of Black girls, the pivotal role of parents cannot be discounted.

Parental Involvement

Parents are influential in the early achievement socialization of Black girls and are responsible for the development of Black girls as learners and doers of science. Achievement is socialized, and within the Black community, gender socialization is uniquely connected to differences in achievement between Black girls and boys. Black girls show strong predilection toward science because of strong female role models; such as working mothers and communities that provide more academic support for girls rather than boys (Hanson, 2006). The results of these trends are commonly observed when data are disaggregated by race and gender. For example, although science gender differences typically favor boys, within the Black student subpopulation, girls outperform boys (National Science Board, 2014). One popular adage of the Black community is that mothers "raise their daughters and love their sons." By “raising” their daughters, this saying suggests that Black mothers better prepare their daughters for challenges of adult life while shielding their sons from the many eventualities (Varner & Mandara, 2014).

This form of gender socialization is in stark contrast to traditional gender socialization patterns, however given that Black girls face “two-tiered dominating patriarchy” that consists of race and gender (Fordham, 1993, p. 5), it is warranted. This type of socialization leads Black girls to be more independent and resilient both socially and academically than their male counterparts. Because Black girls are positioned outside of science and mathematics courses as early as elementary school (West-Olatunji et al., 2008), social and academic resilience are necessary for Black girls to negotiate both racial and gender discrimination, as well as, bias among school personnel (Archer-Banks & Behar-Horenstein, 2012). Thus, parents must socialize academic persistence and resilience in Black girls as early as possible.

Parents are instrumental in helping children develop positive self-concept and identity through socialization. Specifically, parental involvement and expectations are important factors related to Black girl participation in science (Hrabowski, Maton, Greene, & Greif, 2002; Maton & Hrabowski III, 2004; Russell, 2005; Russell & Atwater, 2005). Child rearing practices are typically the mechanism through which these ideals are socialized. Furthermore, many socialization practices are highly dependent on gender (Raley & Bianchi, 2006). Consequently, research consistently concludes that differences in socialization lead to differential achievement outcomes for Black boys and girls (Annunziata, Hogue, Faw, & Liddle, 2006; Kapungu Holmbeck, & Paikoff, 2006; Mandara, Varner, & Richman, 2010). These differences affect student success across the entire achievement spectrum. According to Wood, Kaplan, and Mcloyd (2007), Black student achievement on tests is directly related to differences in parent socialization based on gender. Investigating the differences related to these gender patterns of school achievement warrant further examination, however, for the purpose of this study, establishing Black female content knowledge baselines are paramount.

Problem

Achievement gap analyses and educational reform efforts habitually seeks to identify programs and teaching methods that target the social, emotional, cultural, and psychological dimensions of Black students. These efforts provide a conceptual lens that is necessary for working with diverse populations of students, but little is known about how Black students' subject-matter knowledge may influence achievement differences. Furthermore, between-group analyses impede the identification of within-group content specific strengths and weaknesses. For example, if Black student achievement is always compared to their white counterparts, the focus is always based on closing the gap, when attention should be placed on identifying the knowledge and skills that need remediation. This research study excludes the ethnic and gender comparative distractors and eliminates the need to speculate on the causes of between-group differences, placing the achievement of Black girl in science in the forefront. This study was guided by the following research questions:

1. How is the specialized science content knowledge of Black girls differentiated on the NAEP?
2. How are the dispositions, opportunities to learn, and parental involvement mechanisms characterized by the NAEP assessment data?

Methodology

To gain a baseline understanding of science achievement of Black girls, this study utilized a subsample of Black fourth-grade girls from the 2009 NAEP ($N = 15,520$) (National Center for Education Statistics, 2011). The participants in this study were part of a representative national sample of Black girls, thus the students were selected from schools with varying levels of diversity and socioeconomic compositions. Examination of the data proceeded logically from descriptive to comparative analyses.

Instrument

The science achievement of Black Girls was measured by the 2009 fourth-grade science NAEP. National standards and a focus on inclusive K-12 science education, in addition to

advances in science and cognitive research, informed the development of the NAEP Science Framework (U.S. Department of Education, National Assessment Governing Board, 2010). Recent changes in science education have moved from a focus on discrete facts and breadth over depth to standards that emphasize opportunities that allow students to experience science as it is actually done (Schweingruber, Keller, & Quinn, 2012). The National Science Education Standards (National Research Council [NRC], 1996) and the Benchmarks for Scientific Literacy (American Association for the Advancement of Science [AAAS], 1993) have informed state science standards and pushed K-12 science education towards a more inclusive and authentic science learning experience for all students. These changes are reflected in the design of the content presented on the 2009 NAEP.

The scale for the science NAEP is 0-300 for the fourth-grade assessment. The science NAEP and all the other NAEP subject area assessments are based on Item Response Theory (IRT) statistical procedures. These procedures are used to summarize student performance across a set of assessments requiring similar knowledge and skills. Much like the use of scale scores, these procedures help to promote the consistency across administrations, which support the comparison of data sets from year to year. According to the U.S. Department of Education (2010) the weighted internal consistency of the science exam is approximately 0.72 across administrations. Additionally, the NAEP student data are evaluated on the level of achievement on a given assessment. Table 1 presents a summary of the proficiencies associated with each achievement level on the science NAEP. Each achievement level is based on student performance score ranges that indicate a basic, proficient, or advanced level of science understanding.

Table 1
NAEP fourth-grade science achievement levels

Achievement Level	Minimum Scale Score	Description
Basic	131-166	Students performing at the <i>Basic</i> level should be able to describe, measure, and classify familiar objects in the world around them, as well as explain and make predictions about familiar processes. These processes include changes of states of matter, movements of objects, basic needs and life cycles of plants and animals, changes in shadows during the day, and changes in weather. They should be able to critique simple observational studies, communicating observations and basic measurements of familiar systems and processes, and look for patterns in their observations. With regard to scientific constraints, they should also be able to propose and critique alternative solutions to problems involving familiar systems and processes.
Proficient	167-223	Students performing at the <i>Proficient</i> level should be able to demonstrate relationships among closely related science concepts, as well as analyze alternative explanations or predictions. They should be able to explain how changes in temperature cause changes of state, how forces can change motion, how adaptations help plants and animals meet their basic

		needs, how environmental changes can affect their growth and survival, how land formations can result from Earth processes, and how recycling can help conserve limited resources. They should be able to identify patterns in data and/or explain these patterns. They should also be able to identify and critique alternative responses to design problems.
Advanced	224-300	Students performing at the <i>Advanced</i> level should be able to demonstrate relationships among different representations of science principles, as well as propose alternative explanations or predictions of phenomena. They should be able to use numbers, drawings, and graphs to describe and explain motion of objects; analyze how environmental conditions affect growth and survival of plants and animals; describe changes in the sun's path through the sky at different times of year; and describe how human uses of Earth materials affect the environment. They should be able to design studies that use sampling strategies to obtain evidence. They should also be able to propose and critique alternative individual and local community responses to design problems.

Elementary science education requires an understanding of physical, life, and earth and space science as well as a foundational understanding of the nature of science and scientific practices. Physical science content topics and subtopics include matter (properties of and changes in matter), energy (forms of energy and energy transfer and conservation), and motion (motion at the macroscopic level and forces affecting motion). Life science content topics and subtopics include structures and functions of living systems (organization and development, matter and energy transformation, interdependence) and changes in living systems (heredity and reproduction and evolution and diversity). Earth and space sciences content topics and subtopics include earth in space and time (objects in the universe and history of earth), earth structures (properties of earth materials and tectonics), and earth systems (energy in earth systems, climate and weather, biogeochemical cycles). In addition to achievement data, survey data related to science achievement is also collected from parents, students, and teachers.

Analysis

Mean differences between Black girls' science scale scores for the 2009 fourth-grade NAEP administrations were calculated and accompanied by 95% confidence intervals. A score of 131 is the standard for a basic level of science knowledge on the science NAEP. Using 131 as a baseline, overlap between the 95% confidence intervals indicates a lack of statistically significant difference between the score and the basic level of science. Thus, if the confidence band includes 131 then the mean score is not statistically significantly different from 131. However, if the band does not include 131, then there is a statistically significant difference from 131. Finally, differences in Black girls specialized science content knowledge were assessed using both descriptive statistics and a one-way analysis of variance (ANOVA). Statistically significant mean differences were examined using the three NAEP science scales from the 2009 administration as

outcome variables: (1) Life Science, (2) Earth Science, and (3) Physical Science. Appropriate post hoc testing and a subsequent plot of the 95% confidence intervals for the mean scale score point estimates followed *ANOVA* results. In addition to the *ANOVA*, student, teacher, and parent survey data were aggregated and summarized to provide context to inform the interpretation of the results.

This survey data characterizes the following student, instructional, and parental factors influencing the science achievement of Black girls: (1) dispositions, (2) opportunities to learn, and (3) environmental support. Item scales were primarily adaptations of traditional Likert scales, altered to include appropriately accessible language. For example, teachers were asked, “In this class, about how much time do you spend on earth and space science?”. The observed responses were: None, Little, Some, A lot. While students were asked, “How often do you feel you can do a good job on your science tests?”. The student possible responses were: Never or hardly ever, Sometimes, Often, Always or almost always. Data were organized based on the three aforementioned constructs and percentages of responses in each category were reported.

Results

The descriptive statistics for the science achievement on the composite and individual science scales are presented in Table 2. The composite scores for Black girls are statistically significantly lower than 131, or the standard for a basic understanding of science. This is based on the exclusion of 131, in the 95% confidence interval for science composite scores. Mean scores on the individual science scales suggests that only earth science was statistically significantly different from 131, or statistically significantly lower than the basic level of understanding. A goal of the present study was to test for differences between Black girls mean scale scores on the life science, earth science, and physical science NAEP. The *ANOVA* results were statistically significant, $F(2, 15,518) = 45.98, p < 0.001$.

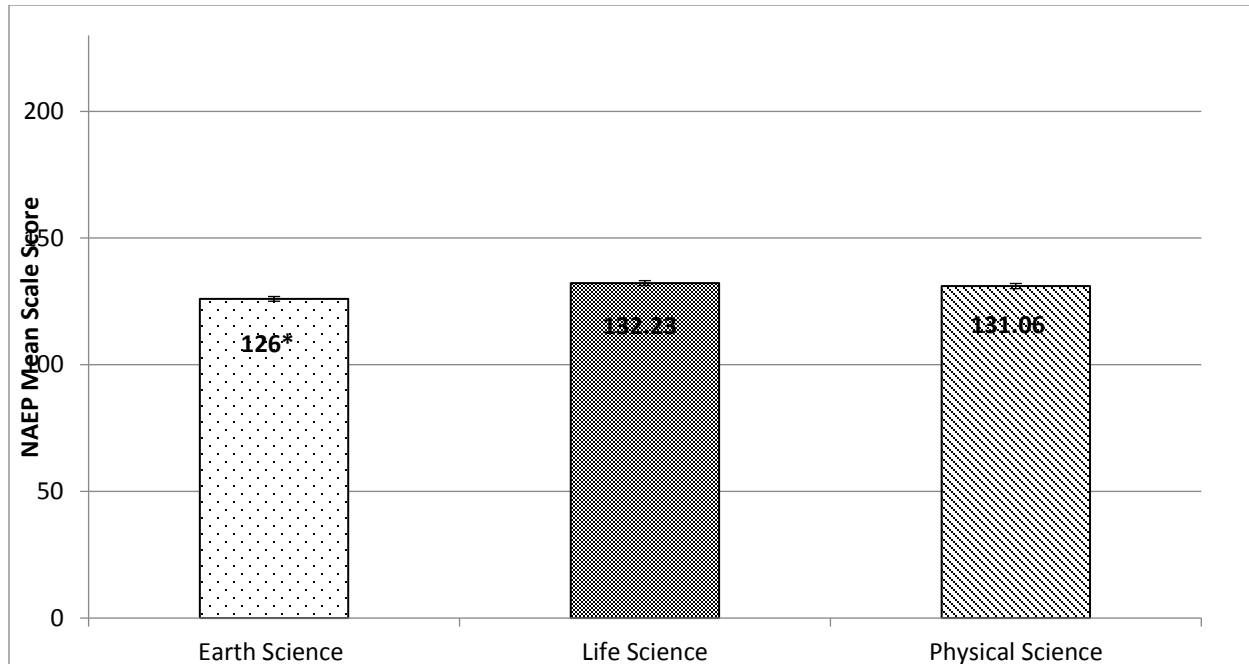
Table 2

Descriptive Statistics and Fourth Grade Black Girl Science

	<i>N</i>	<i>M</i>	<i>CI</i>
Composite	5184	129.53(32.04)	[128.64, 130.42]
Earth Science	4394	126.00(31.62)	[125.04, 126.95]
Life Science	4275	132.23(32.43)	[131.23, 133.22]
Physical Science	3852	131.06(32.21)	[130.01, 132.11]

Note. Maximum possible score of 300

A pictorial representation of the mean differences is provided in Figure 1. Figure 1 presents the 95% confidence intervals in bar graph form for Black girls mean scores on each of the fourth grade Science content strands. The results presented in Figure 1 suggest that Black girls scored statistically significantly lower on the earth science scale based on the lack of overlap between the confidence interval bands in the other content areas. Score differences between the life science and physical science scale scores were not statistically significantly different based on the overlap between confidence bands.



Note. An asterisk represents a statistically significant difference between mean scale scores.

Figure 1. Bar graphs with 95% CI for Mean Scale Scores for the fourth Grade NAEP Science Assessment Measures

Four factors related to the science achievement of Black girls were characterized using survey response data. The first factor was science dispositions. Table 3 presents the student disposition survey responses. The data in Table 3 suggest that the majority of Black girls are confident in their ability to perform on science test and assignments. Conversely, approximately 55 % of Black girls struggle to understand science instruction often or almost always. Consequently, a similar percentage (56%), of Black girls report that science is hardly ever or only sometimes their favorite subject.

Table 3

Summary of Black girl self-reported responses to science dispositions items

	<u>Never</u>	<u>Sometimes</u>	<u>Often</u>	<u>Always</u>
1. How often do you feel you can do a good job on your science assignments?	9%	30%	26%	35%
2. How often do you feel you can do a good job on your science tests?	8%	32%	24%	36%
3. How often do you feel you can understand what the teacher talks about in science class?	7%	39%	23%	32%
4. How often do you feel science is one of your favorite subjects?	24%	32%	19%	25%

Note: All data presented in percentages. Detail may not sum to totals because of rounding. Some apparent differences between estimates may not be statistically significant. N = Never or hardly ever, S = Sometimes, O = Often, A = Always or almost always, (N = 15,520)

SOURCE: Adapted from U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment.

Factors related to opportunities to learn are presented in two categories: (1) teacher preparation and (2) science teaching. Teacher self-report credentials and professional development related science instructions are presented in Table 4. According to Table 4, the majority of Black girls receive instruction from traditionally certified teachers. Furthermore, almost half of the teachers have an advanced degree in elementary education or a related field. However, many of the teachers currently teaching science to Black girls lack continuing education to support their science pedagogical practice. Specifically, 87% and 95% of teachers surveyed did not participate in science related professional development in last two years or lack graduate coursework related to science instruction respectively. Figure 2, summarizes the teacher’s role in teaching science and the amount of time spent each week teaching science. The data in Figure 2, suggest that the majority teachers serving Black girls report teaching science less than 4 hours a week. In addition, Figure 2 shows only 3% of teachers serving Black girls teach science exclusively.

Table 4
Summary of Teacher reported credentials and preparation related to opportunities to learn

	<u>Yes</u>	<u>No</u>
Did you enter teaching through an alternative certification program?	13%	87%
Did you have a major, minor, or special emphasis in elementary or early childhood as part of your graduate coursework?	46%	54%
During the last two years, did you participate in or lead any of the following professional development activities related to the teaching of science?	13%	87%
Did you have a major, minor, or special emphasis in science education as part of your graduate coursework?	5%	95%

Note. All data presented in percentages. Detail may not sum to totals because of rounding. Some apparent differences between estimates may not be statistically significant. (N = 15,520)
 SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment.

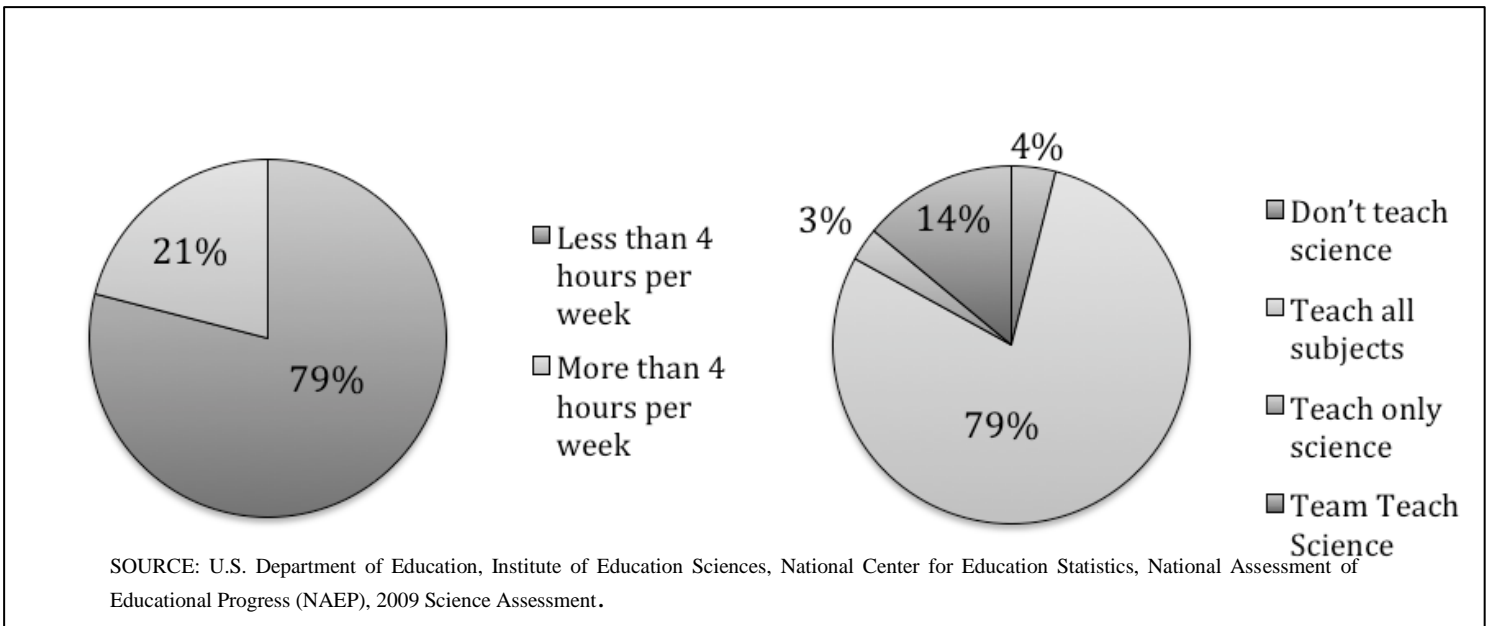


Figure 2. Teacher self-reported Science instructional roles related to opportunities to learn

Table 5 presents the teacher reported time spent on each of the science content strands measured on the NAEP. The teacher self-reported data suggest that the majority of teachers consistently reported spending some to a lot of time on each of the content areas measured on the NAEP. Only 12-15% of teachers claim to spend little to no time on each of the content strands.

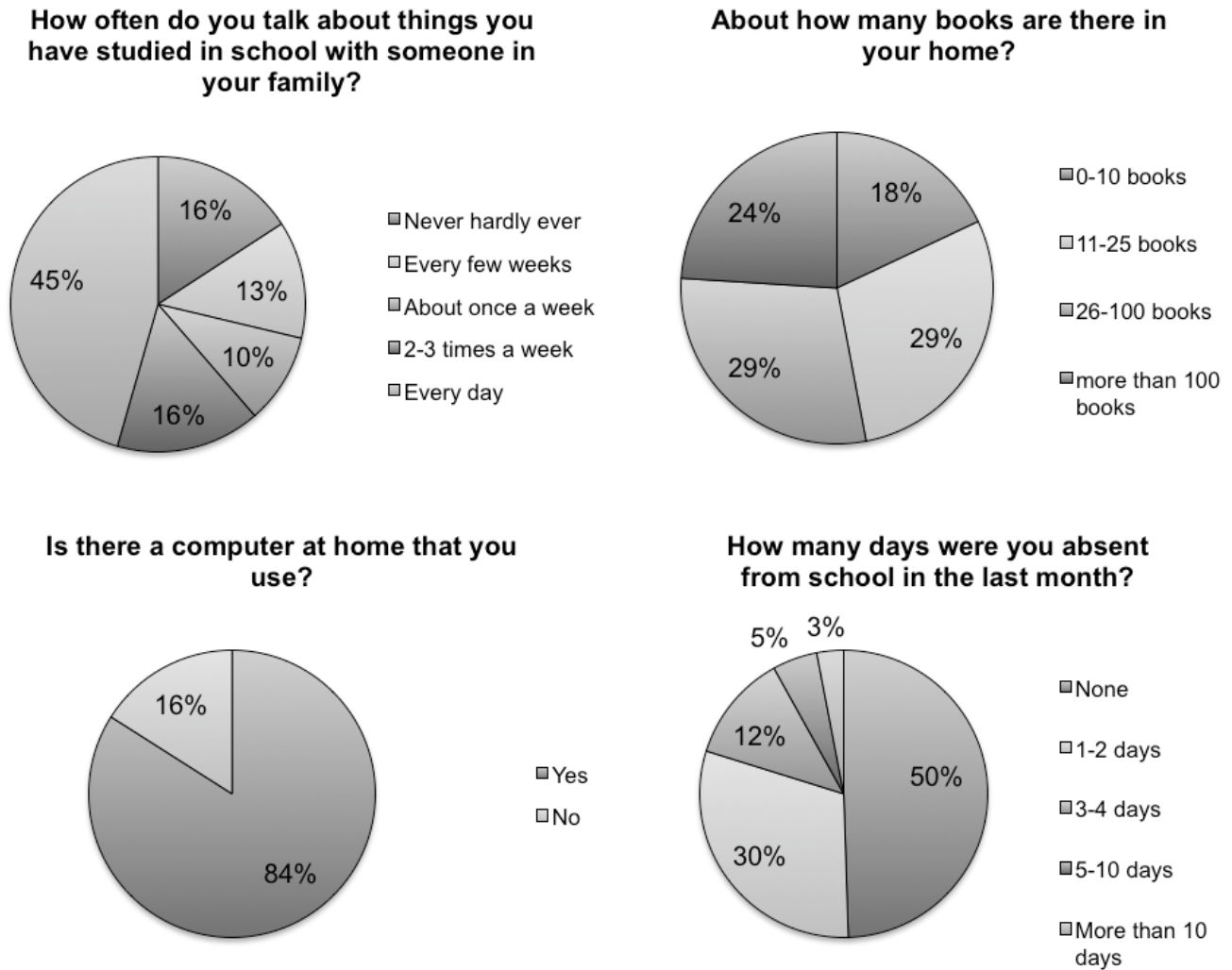
Table 5

Summary of teacher reported time spent on science content related to opportunities to learn

	<u>None</u>	<u>Little</u>	<u>Some</u>	<u>A lot</u>
1. In this class, about how much time do you spend on earth and space science?	3%	12%	58%	28%
2. In this class, about how much time do you spend on life science?	2%	10%	55%	33%
3. In this class, about how much time do you spend on physical science?	3%	12%	58%	28%

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment. NOTE: All data presented in percentages. Detail may not sum to totals because of rounding. Some apparent differences between estimates may not be statistically significant. N = None, L = Little, S = Some, A = A lot

Parental antecedents to science achievement are presented in Figure 3. The majority of Black girls claim to talk about school with their family every day, while the remaining 55% of responses range from never to two to three times per week. The data for the number of books in the home represents a relatively even distribution of responses. While an overwhelmingly large number Black girls reported to have a computer in the home. Finally, 50% of Black girls reported perfect attendance in the last month, and 30% reported missing one to two days.



SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment

Figure 3. Parental and environmental factors associated with Black girl achievement

The data suggest that the remaining students were absent between three to more than 10 days. A contextualization of the results as well as implications for teachers, parents, and students are presented in the discussion.

Discussion

The results of this study have important implications for science teaching and learning. First, the results of this study suggest that the achievement of Black girls is highest in life science followed by physical science, and earth science. Based on the results of this study, we suggest that Black girl science knowledge in grade 4 is best characterized as below the basic level. These results do not confirm, but rather enhance previous analyses. These results are consistent with prior research that suggest that only 10% of Black students performed at proficient or advanced levels

on the science NAEP, whereas 43% of White students scored at these levels (Aud et al., 2011). However, unlike previous studies we offer educators, researchers, and parents a holistic view of the entire performance profile.

We would be remiss not to acknowledge that Black girls have some substantial challenges in the area of science. For example, the majority of fourth-grade Black girls lack the science proficiency necessary to: (1) demonstrate relationships among closely related science concepts; (2) analyze alternative explanations of predictions; and identify and critique alternative responses to design problems (National Center for Education Statistics, 2012). All of which are critical ideas and skills used to scaffold knowledge at the middle and high school level.

Yet Black girls can: (1) recognize a related individual based on physical characteristics; (2) identify the source of energy used by a home appliance; and (3) place stages of a life cycle in correct order. Using a strength-based growth mindset is crucial to the affirmation of Black girls as learners and doers of science. Our examination of knowledge on the individual science scales indicates that statistically significant differences were present in Black girls' science knowledge. Hence, Black girls have scientific knowledge strengths and challenges. Addressing these strengths and challenges is important given the affects of stereotype threat, testing anxiety, and other psychological variables on the achievement and course avoidance patterns of women and people of color in STEM (Deemer, Smith, Carroll, & Carpenter, 2014; Smith, Brown, Thoman, & Deemer, 2015; Young & Young, 2015; Young, & Young, 2016b). The study also has important implications to inform research and praxis in the development of scientific dispositions in Black girls.

The results of this study suggest that the scientific dispositions of Black girls diverge in regards to self-efficacy and attitude. Although some dispersion exists within the reported self-efficacy percentages, the majority of Black girls believe that they can be successful learners and doers of science. However, the attitudinal item suggests that science is not appealing to the majority of Black girls. Given that interest is related to achievement, it is important that parents and educators take notice to this trend in the data. Early science engagement has a substantial effect on the persistence and performance in scientific domains for all students. But, given the need to diversify the STEM workforce, this is a major consideration for Black girls. Teachers are crucial to providing these opportunities to learn.

Teacher-related results are important because they better inform inferences related opportunities to learn and the lack of these opportunities for Black girls. Contrary to many reports on opportunities to learn, the results of this study suggest that the majority of teachers serving Black girls are traditionally certified, and have some graduate course work in education. This is salient because many teacher-quality and opportunities-to-learn arguments are built on the lack of traditional qualified teachers compared to alternatively qualified teachers. However, it is important to note that further study is necessary to determine if this trend is consistent at middle and high school levels. Despite this promising result, there were also some concerns related to teacher quality and opportunities to learn science.

Many of the teachers serving Black girls reported a lack of continuing education and preparation to teach science. This is important because deeper, content specific, pedagogical

knowledge could help teachers better explicate the utility of science to Black girls. Additionally, almost 80% of teachers reported teaching science less than four hours per week. This is less than an hour per day in a five-day school week. The lack of instructional time allocated to science is also present in the teacher self-reported role of science in their teaching load. The majority of teachers teach all subjects based on the reported data, while only 3% reported teaching science exclusively. Furthermore, despite significantly lower scores in earth science, teachers do not report spending substantially less instructional time on this content. This is an important finding because it is counterintuitive, given that earth science was the lowest performing area for Black girls. In summary, the results of this part of the study indicate that Black girls receive instruction from highly qualified traditionally certified teachers, but the teachers may lack resources, training, and institutional support to actualize the benefits of their credentials to teach science effectively for Black girls.

Parental support is influential in the achievement of all students. The results of this study characterized parental support mechanisms in regards to socialization achievement in Black girls. Based on the results provided by the survey items, the familial influences are primarily productive. The broad nature of the survey items however limits the ability to make claims directly or exclusively to the science content area. The majority of Black girls report talking with family about school everyday, which is indicative of academically supportive parental influences. This is contrary to many accounts and reports indicating that Black parents do not support their children academically. The number of books in the home is historically related to the achievement of all students. Thus, it is important to note that number of books in the home reported by Black girls is distributed relatively evenly across the categories. One major interpretive consideration with this item is that books take up space, and therefore you need more space to own larger numbers of books. As the utilization of electronic books becomes more commonplace, it is important to consider how reading on a tablet may affect these results. Consequently, this item may be more indicative of wealth rather than achievement orientation. Finally, our results suggest that more parental attention should be placed on attendance. Approximately, 50% of Black girls' report missing at least one day of school in the last month. Although one day does not appear to be substantial, the instruction missed during that one absence could be detrimental to the comprehension of subsequent instruction. Furthermore, consecutive absences can begin to socialize academic indifference rather than achievement in Black girls if attendance is not a priority.

Conclusion

Achievement trends in elementary science indicate that students perform better in life and physical science than earth and space science content. The NAEP data for fourth grade Black girls follows this trend. NAEP science assessment measures indicate that in life and physical sciences, Black girls have a basic proficiency. In earth science, Black girls mean scores indicate a below-basic understanding of earth and space sciences. In conclusion, the data from this study provide a comprehensive view of the early science achievement of Black girls. Based on this data we conclude that overall Black girls possess a positive academic science disposition, but are not engaged in the content. One aspect related to increased engagement is the development of a positive learner identity. According to Varelas, Martin, and Kane (2013) working with Black students in STEM classrooms requires the consideration of three intersecting identities: racial

identity (a Black girl's emerging understandings of what it means to be Black), disciplinary identity (a girl's ability to see herself as a doer of the discipline, i.e. science), and academic identity (a student's ability to see herself as a participant in academic tasks and classroom practices). We hope that parents will help Black girls develop a positive racial identity. The achievement socialization of Black girls is well documented as means to increase their performance across STEM content areas (Young, Young, & Capraro, 2017; Young, Young, & Paufler, 2017). This is an important aspect of learner development that can be addressed through parental socialization practices.

“Preparing future teachers in ways to adequately instruct females of color requires that they be well versed in the latest research-based theories and methods of pedagogy” (Walls, 2013, p. 41). Pre-service teacher education must address and challenge the pre-service teacher's conception of what it means to effectively teach students who are underserved in their education (Mensah, 2013). Including constructivist learning theory, inquiry-based instruction, the nature of science, and multiculturalism will allow future educators to reach the goal of reaching all learners (Walls, 2013). These research-based theories and methods of pedagogy requires teachers to be aware of the cultural experiences of their students, responding to their students as creators of learning, taking full advantage of the multiple cultures students are immersed in before, during, and after classroom experiences. In this light, culturally responsive pedagogies that resonate with many Black girls, such as hip-hop pedagogies, warrant consideration in elementary classrooms (Emdin, Adjapong, & Levy, 2016). These topics are worth explicit implementation in initial and continuing teacher education programs. Elementary science teachers are uniquely positioned to address Black girl disciplinary and academic identity. Thus, we also recommend that teachers receive science-specific continuing education and support to create more accessible and engaging experiences for Black girls in early science.

In closing, it takes a community to raise a child, and if Black girls are to become successful learners and doers of science - teachers and educational stakeholders must become one community. In-service professional development must attend to the issues of diversity and bridge multicultural theories and practice in the context of diverse classrooms (Mensah, 2013). These experiences can help Black girls develop positive disciplinary and academic identities. Elementary science teachers are required to have an extensive knowledge of a diverse and changing content as well as an understanding of the context of their students' lived experiences if they are to successfully respond to the calls to facilitate a constructivist-based classroom. Teachers who reach out to the community surrounding their students, including teachers, neighborhood churches and centers, and other stakeholders, they will be better versed in the context of the science that exists within the lived experiences of their learners. When teachers possess a deep and rich contextualized content knowledge base, they are better equipped to identify the inherent science in the daily activities of Black girls; thus, helping them to identify as doers of science.

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