Enhancing Girls' Participation in Science in Nigeria

A Driver for National Development and Social Equality

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"On a worldwide scale, science... is still a man's business. This situation is no longer acceptable. It is economically unacceptable because of the waste of human resources that it entails; it is humanly unacceptable since it prevents half the population from taking part in building the world; it is intellectually unacceptable as it deprives scientific and technological research of ideas and methods, in a word, of creativity. Furthermore, it mortgages the future since it nullifies any prospect of a general mobilization in support of science in the service of a lasting peace and sustainable development".

—Federico Mayor (1999), the Director General of UNESCO[1]

This paper reviews the issue of girls' limited participation in science in Nigeria, which is also an issue throughout many countries in Africa. It reviews the literature on the factors affecting girls' learning and analyzes the situation in Nigerian classrooms. Key among the factors contributing to the science gender gap are cultural biases that hold that science is the domain of males, that it is not important for girls' future lives, and that girls are not as capable as boys when it comes to science learning. These biases are manifested in science curricula, instruction and assessment, and they thus influence the attitudes of both girls and boys, along with parents and teachers. This paper makes the argument that girls must be engaged in science at the early primary school level because this is when their interests and attitudes about learning are formed. Sensitivity to gendered cultural norms that affect classroom practices and students' learning is critical, and policy responses are also needed in order to bring girls into science from an early age.

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Drawing on best practices for promoting gender equity in science, the paper recommends six areas in which measures can be taken to improve science education for girls and boys in Nigeria: improving data quality and accessibility; incorporating gender equity training into teacher education; using storytelling as a means to enhance learning and interest in science classrooms; building on science, technology, engineering and mathematics (STEM) initiatives in Nigeria; women helping women in science; and enhancing partnerships to promote girls' participation in science.

THE IMPORTANCE OF SCIENCE AND SCIENCE EDUCATION FOR ALL

Science plays a central role in contemporary society, with the potential to improve lives in a multitude of ways and advance national development. Access to the fruits of science at the individual and collective levels, however, lies primarily with those endowed with scientific knowledge and skills. Increasingly, those with the greatest understanding of science and technology have access to the best information, opportunities and jobs. Science can be regarded as the cornerstone of industrial development and the link between technology and socioeconomic development. A country's ability to secure good health, fight diseases, protect the environment, produce food for its people, and develop new industries and technologies is dependent on the scientific knowledge and skills of its people. Any nation that neglects the provision of good quality science education may quickly find itself the dumping ground of other people's innovations, without the necessary human resources to sustain growth and compete in a global economy.

Recently, global discussions on education have moved from focusing primarily on school *access* to placing greater emphasis on the *learning* that takes place in classrooms, and science is a critical part of the learning that all children need to acquire. Although primary school enrollment in sub-Saharan Africa has increased from 59 percent to 77 percent in the last decade, large numbers of children leave school without acquiring basic knowledge, skills and competencies.[2] 45 percent of the 128 million children of primary school age in Africa are not learning basic literacy and numeracy skills after four years of school, per the Africa Learning Barometer.[3] While science competency is not systematically assessed in most African countries, there are indications that science education remains weak.[4] Science and technology are among the seven learning domains that are foundational to lifelong learning for any child, as identified by the Brookings Institution's Learning Metrics Task Force. A lack of adequate competence in these cognitive and noncognitive areas will hinder children from effectively learning as they progress through higher levels of education and from becoming healthy, productive adults.

Like other countries in the Global South, Nigeria has in recent years sought to ensure equitable access to education for all (box 1). In this context, girls' access to education has received attention at the policy level, and progress has been made toward gender parity in enrollments in some regions of the country. However, far less attention has been paid in Nigeria to the quality of children's learning and to girls' participation in different areas of learning, including science and technology.

While the Nigerian government has in recent years focused attention on strengthening na-

tional capacity in science and technology—a key recommendation and objective of its Vision 20:2020 plan for economic transformation—it has yet to fully recognize the importance of gender equity in science education and has not initiated any national policies toward this goal. Female participation in science receives mention in Nigeria's most recent Science, Innovation, and Technology Policy, but no specific objectives have been developed.[5] This, in part, is due to a lack of awareness in Nigeria of the problem of the science gender gap and the importance of girls' and women's participation in science. Education for all understood in terms of equal access to education is not enough. Equality and the future development of societies are dependent on providing a high quality science education for all.

Box 1. Basic Education in Nigeria Snapshot

Data on Nigerian education reveal that effective policies are needed to improve both access and learning, particularly for girls. Nigeria has one of the largest out-of-school populations in the world, with 10.5 million children not enrolled in school.[6] Of the children who are enrolled in primary school, 47 percent are girls. Girls' enrollment further declines to 44 percent at the junior secondary school level.[7] The survival rate to the last grade of primary school is 69.8 percent for girls and 77.4.[8] Only 53 percent of all students throughout the country transition to secondary school.[9]

There are, however, considerable regional disparities in school access. In the northern states, gender disparities in enrollment remain great, while considerable progress has been made toward gender parity in access to education in southern Nigeria. Only 4 percent of girls and 3 percent of boys from rural areas and less than 1 percent of boys and girls from urban areas are out of school in the south of the country.[10]

Going beyond access, many Nigerian students are not learning the basic skills they need to succeed. Sixty percent of students who have completed grade 4 and 44 percent of students who have completed grade 6 are not able to read a complete sentence in any language.[11] Numeracy rates show about 10 percent of students unable to do basic addition by the end of primary school.[12] In the North, learning outcomes are particularly bad; more than two-thirds of students who have completed grade 6 remain illiterate. A recent survey in Sokoto State in the Northwest Savanah region found that 80 percent of Grade 3 pupils are not able to read a single word.[13]

While recognizing the many pressing concerns and unevenness of educational provision in Nigeria, this paper focuses on improving science education and learning for girls, as well as boys, who are already enrolled in school at the primary level. The potential of these more than 20 million children to contribute to Nigerian society if given the adequate encouragement and training in science education must not be squandered.[14]

WOMEN AND GIRLS' PARTICIPATION IN SCIENCE

An Opportunity for National Development and an Imperative for Social Equality

Closing the gender gap in science is of critical importance for all countries because failure to do so means the loss of vast human resources that could contribute to national development and could further entrench gender inequality in society.

Box 2. Underrepresentation of Women in STEM Fields and Science Research Globally

In the United Nations Millennium Declaration, member countries avow "to promote gender equality and the empowerment of women, as effective ways to combat poverty, hunger and disease and to stimulate development that is truly sustainable."[15] Although progress is being made to increase women's participation in many fields, UNESCO figures reveal that women make up a minority of the world's science researchers. In 121 countries with available data, women make up 29 percent of science researchers.[16] Throughout the world, women continue to be significantly underrepresented in every sector of science, technology, engineering and mathematics (STEM). Men outnumber women as students, educators, researchers, and workers in these fields. While the number of women enrolling in higher education is increasing rapidly in many countries and in some has surpassed male enrollment, men significantly outnumber women in science and engineering disciplines.[17]

A country's ability to create, apply and diffuse scientific and technological knowledge is now a major determinant of its socioeconomic development and national competitiveness. This potential, however, cannot be fully realized without making the best use of the entire population of a nation—including girls and women. Most African countries lag behind in the generation of the human technological capacity on which further economic development is heavily dependent. "If only more girls could be persuaded to take up science and technology subjects in schools, and could be persuaded to do better in them, the countries, so the argument goes, would have the benefit of an increased technological output with few extra inputs."[18] There are 69 million women and girls in Nigeria;[19] their exclusion from the generation and application of scientific knowledge represents a tremendous waste of human potential.

Women undertake 60 to 90 percent of agricultural production activities in the developing world, and they carry the primary responsibility for providing for the water, energy, sanitation and health care needs of their family and communities.[20] Moreover, their exclusion from participation and high achievement in science education means that they have limited access to jobs in these fields, which are among the fastest growing and highest paying. Studies have shown that a student's performance in science and mathematics is a strong indicator of later earnings.[21] This is the case even within the education system itself, where teachers and lecturers in science are often paid more or have a competitive advantage over their colleagues in other fields.[22] It is also in science and mathematics subjects that many of the cognitive and noncognitive skills necessary for individual and national development, such as higher order thinking and problem solving, are expected to be learned.[23] For science to largely remain the domain of men is a sure means to perpetuate existing inequalities on the basis of gender in society.

Closing the gender gap in science is also essential for ensuring that women as much as

men benefit as citizens and contributors to their societies. Women should not be limited to being passive users of science and technology but instead should be active participants in scientific development, application and decisionmaking, ensuring that science and technology initiatives are implemented to address the needs and preferences of both sexes.[24] Astoundingly, research has found that "after decades of S&T [science and technology] interventions in development, women's overall position actually declined relative to men's, and women have become disproportionately poor in comparison with men in their communities."[25] Therefore, the gender gap in science and technology must be more effectively addressed to benefit both society and the individual. As women increasingly participate in science and technology, their communities and nations will also reap the benefits. However, educationalists must reexamine the pedagogy and practice of science, given the ongoing underrepresentation of girls and women in science.

THE SCIENCE GENDER GAP IN NIGERIA

Where sex disaggregated data is available, the general trend in African countries is that fewer girls choose science subjects as they progress through the education system, and they are outperformed by boys in some countries. Reliable and comprehensive data on gender parity in science participation and performance at the secondary school level and lower are not readily accessible in Nigeria. Available girls enrollment data from Nigeria shows the trend of under enrollment in physical science classes at secondary level. The gender parity index (GPI) for Biology of 0.83 reflects the GPI for secondary school overall as it is a required subject. In contrast, the GPI for Physics is 0.73 and the GPI for Chemistry is 0.73. This trend is exacerbated as students progress to university and to pursue teaching as a profession.[26] By the time students reach the university level, it is evident that women are underrepresented and unevenly concentrated in science subjects. Table 1 shows the percentage of female university students enrolled in science and technology courses across 12 states in Nigeria from 1998 to 2002. While numbers in both groups increased from to 1998–99 to 2001–2002, the ratio of men to women remained about the same, at 3:1.

Table 1. Percentage of Female University Students Enrolled in Science and Technology Courses in 12 Nigerian States, 1998–99 to 2001–2002

Year	Science	Technology
1998–1999	32.2	17.3
1999–2000	33.9	16.1
2000–2001	29.3	14.2
2001–2002	25.9	23.4

Source: Federal Office of Statistics, 2003 abstracts.

In 2001–2002, women made up only 23 percent of students in technology courses and 26 percent of students in science courses. The gender disparity in science enrollment actually increased over these years. The underrepresentation of women in university science courses is reflected in the fact that women make up only 17 percent of all science researchers in Nigeria.[27]

Data gathered at the University of Ibadan, Nigeria's oldest university, reveal a trend consistent with international findings on women's choice of subject (box 3). A majority of women who choose to pursue an undergraduate science degree pursue the life sciences.

Box 3. Gender Disparities in Fields of Study

Studies in multiple countries indicate consistent differences in the fields of study that boys and girls choose to pursue. They point to a trend in which girls have a greater preference for the biological sciences than boys, who prefer the physical sciences or have a broader range of preferences. These studies also reveal that children often hold stereotypical views about the physical sciences being "for boys" and the biological ones being "for girls." Such preferences and attitudes are reflected in performance, with boys on average outperforming girls in physics and in higher level questions in assessments.[28]

Overall, women make up just under 35 percent of students in these science faculties, while they make up 42.6 percent of the total number of undergraduate students. Women tend toward clinical science and public health, yet they are significantly underrepresented in the science, technology, and engineering faculties (37.6 percent female and 16.4 percent female, respectively).

THE IMPORTANCE OF THE PRIMARY SCHOOL LEVEL

It is vitally important to cultivate interest in science while girls are still engaged and to affirm from an early age that science belongs to them as much as to boys. Research on girls' and boys' engagement in the sciences reveals that disparities in participation and interest tend to widen as students transition to higher levels of education.[29] In many African countries, women transition to secondary school in lower numbers than boys and enroll in fewer science classes. As already noted, those women who study science at the university level are less likely than men to concentrate on science, particularly the physical sciences and engineering. And the numbers drop off even more starkly from there. This trend in science education has been termed "the leaky pipeline," because so many girls and women drop out along the way.[30]

Although science is a compulsory component of the primary school curriculum, so that participation is not yet an issue, it is at this level that gender disparities in interest, and in some cases performance, begin to emerge in Nigeria and in other countries. At the earliest ages (below seven years), few differences in children's engagement in science are documented.[31] Research on primary science teaching in Nigeria conducted in 10 schools in Oyo State indicated that disparities in interest in favor of boys begin to appear at the upper primary school level and could be tied to performance.[32] Likewise, other research on science education in Nigeria traced the constant decline of girls' interest, and in some cases performance, in higher education and secondary school science to the experiences that girls had in their primary science classrooms.[33] Studies in other African countries also indicate that gender disparities favoring boys set in by the end of primary school—for example, in mathematics skills, positive attitudes toward science, and confidence to participate in science class.[34]

So while the gender gap widens as students get older, there is consensus among researchers that interventions to advance girls' learning and address the gender inequity in science need to start at an early age (box 4).[35]

Box 4. Current Efforts Start Too Late

In one study in the United States, 116 interviews were conducted with graduate students and scientists about the timing, source, and nature of their earliest interest in science.[36] It was found that the majority (65 percent) of the participants traced their initial interest in science to before middle school (junior secondary). The study also found that while most male participants recounted self-initiated science activities, females more often reported that their interest was kindled by activities in school. The authors conclude that "current policy efforts (which focus on high school science reform) to increase the numbers of students studying in the science fields, may be misguided."[37]

Early science education, particularly in primary school, is important for several reasons. One reason is that the acquisition of skills that occurs in early childhood and primary school serves as the foundation for all future learning. According to the Nobel Prize winning economist James Heckman, interventions in the early years have a higher rate of return per dollar invested than those targeting older children and adults.[38] During these years, children have the greatest opportunity to develop the cognitive and noncognitive skills that can lead to greater achievements later in life. A study conducted in Malawi examining the importance of early learning, for example, found that children's development and mathematical ability at the age of five predicted mathematics ability and school learning outcomes in adolescents at age twelve.[39] Similarly, research on brain development shows that the thinking skills necessary for problem solving are best developed between the ages of four and twelve, which is when most children are in primary school.[40]

The early years (from birth to eight) are also the period when the brain is most "plastic." Attitudes are highly malleable at this age but have a long-term impact on learning.[41] A longitudinal study conducted in the United States on children's beliefs about their own academic competency found that girls rate their mathematics ability lower than boys from an early age, despite the fact that no actual difference in math achievement exists.[42] Such findings are significant because students with greater self-confidence in their science and quantitative abilities are more likely to do well in these subjects and to pursue careers in these fields.[43] This again corroborates the fact that early intervention is vital for increasing girls' self efficacy and participation in science. The tendency for learning disparities to emerge between boys and girls during primary school in many African countries also indicates that girls experience an early and significant disadvantage in these contexts.

More children are now enrolled in primary school in Nigeria than ever before, and all primary school students study science. Primary school therefore holds the potential to ensure that both girls and boys develop positive attitudes toward science from the start, and develop a strong foundation for future learning. But this means that gender equity must be promoted in science classrooms and that practices supporting girls' learning of science must be employed. A gender equity approach, which goes beyond trying to treat girls and boys the same, recognizes the prevailing gender inequality in the field of science and in society. It advocates for a strategic focus on girls in order to promote their participation, higher achievement and interest in science.[44] This does not, however, disadvantage boys. What is good for girls is also good for boys. Equity and high quality very clearly work together in the case of science education.

REASONS FOR THE SCIENCE GENDER GAP

Various factors have been identified as contributing to women's and girls' continued low rate of participation and, in some contexts, underperformance in science. Many of the arguments can be classified under the nature versus nurture debate. One argument, for example, is that because girls' brains develop differently from boys', biological differences explain the gender gap in science. Some have posited that the developments in boys' brains result in better developed visual spatial ability than that possessed by girls, and that this could explain differences in abilities and interest in mathematics and some science subjects.[45] Others find the evidence inconclusive and dispute the argument that biological factors cause gender differences in performance or interest in science.[46] Moreover, the fact that in some countries girls perform as well as or even better than boys in science would seem to contradict the view that gender disparities are due to innate, biologically determined characteristics (box 5).[47]

Box 5. International Trends: Counterevidence to the View That Boy Are "Naturally" Better at Science Than Girls

The most recent TIMSS, conducted in 2011, gathered data from 63 countries regarding student performance at the fourth and eighth grade levels. Although only two African countries (Botswana and South Africa) were included, the study revealed that in 10 countries, girls outperformed boys in science in the eighth grade. In 9 countries, gender disparities in performance favoring boys persisted, but in 12 countries that had previously shown such a disparity, gender parity has now been achieved.[48] This provides counterevidence to the view that girls are not as capable as boys of learning science.

It is not surprising, then, that research gathered in multiple cultural contexts draws attention to extrinsic factors that contribute to the persistence of the gender gap in science participation, interest, and, in some contexts, achievement. The most influential of these factors are sociocultural beliefs that favor males and classroom practices that discourage girls in their pursuit of science. These include societal beliefs about females' innate abilities and social role biases in the curriculum, teacher–student and peer interactions, and the methods of pedagogy and assessment.

Sociocultural Beliefs and Practices

In many African countries, girls' exclusion from science can be attributed largely to the construction of feminine identities, ideologies of domesticity and gender stereotypes.[49] Formal and informal sociocultural norms and expectations about the role of females in society have tremendous effects on girls' educational opportunities, learning outcomes and decisions about study and work.

At the most basic level, obstacles to school access and retention remain fundamental barriers to girls' participation in science, both as children and adults. Girls outnumber boys among children out of school, and they are more likely to begin schooling at a later age. In Nigeria, late school entry is a particular problem among poor children and girls. Less than 50 percent of the poorest girls are enrolled in school at age six.[50] Girls also face greater constraints on pursuing their studies due to household demands on their labor, threats to their physical safety, a lack of necessary sanitation facilities at school and societal beliefs that privilege investments in boys' education.[51]

Beyond access, cultural biases that impede girls' learning and pursuit of science are significant. Gender biases and discrimination play out

acutely with respect to science, particularly the physical sciences, engineering, mathematics and to some extent computer science, which continue to be seen as the domain of males.[52] Education, in general, and science education, in particular, are often viewed as being of less value to girls, given the cultural expectations about their primary roles as wives and mothers. Parents may directly dissuade girls from pursuing science or indirectly convey their differing expectations by insisting that boys take science subjects and leaving girls to choose what they want to study.[53] Girls themselves—as well as their families, teachers and school peers—question the relevance of science to their own lives.[54] People may even doubt that a woman can be trusted to fly a plane or supervise a road's construction, which are viewed as entirely a man's domain. Such beliefs have a negative impact on girls' practical and academic interest and learning in science. In many countries, studies have shown that girls, on average, tend to perceive science as difficult, uninteresting or unappealing in the future prospect it offers.[55] Girls may be further discouraged by the prevalent perception that they lack the ability and, in some contexts, the "toughness" to succeed in the sciences. This is of great consequence to learning, given that there is a strong correlation in science and mathematics between positive attitudes and high performance.[56]

Such gendered stereotypes are often ingrained early in life and are difficult to overcome. There is a prevalent view in Nigeria that women's and men's traditional roles in society should be preserved, and therefore girls should not compete with boys in class. Those who do pursue science can be stigmatized as aberrant or, at best, deemed "exceptional," whereas boys are presumed to have a "natural ability."[57] Views about the proper conduct for girls—as submissive, reserved and unquestioning—shape student–teacher and peer interactions in schools and thus have implications for girls' learning.[58] In most societies, a girl's choice to study science is also seen as weakening her identity as a girl and as making her appear less feminine.[59] In contexts where a girl's worth and material circumstances, as well as those of her family, are intimately tied to her marriage prospects, the implications of challenging the dominant construction of female identity are not easily dismissed.

Additionally, the notion of gender equality is often dismissed as a Western import and a vestige of colonialism.[60] But with more women accessing science education and careers, even if in small numbers, these views are beginning to change. Nigerians are increasingly able to point to female role models such as Grace Alele Williams, who was the first Nigerian woman to obtain a doctorate, in mathematics education, and who then rose to become the first female vice chancellor of the University of Benin. Nonetheless, Nigerian women's lack of visibility in the sciences, and the lack of recognition that they can play a part in the sciences, at both the local and national levels, persists.

These different forms of cultural bias and discrimination against girls in relation to their participation in science greatly exacerbate their lack of self-confidence, which often translates into a lack of interest and leads them to drop out of science classes. As girls get older, they tend to become less confident in their abilities, even if they are performing at the same levels as their male peers,[61] and thus they often show science- and mathematics related anxieties,[62] and come to believe that science is not for them.[63]

Classroom Practices

Motivation and interest arouse a student's curiosity to learn, respond and attend to subject matter. Students' ability to learn is affected by both extrinsic motivation—their engagement with a subject or activity in order to receive reward or avoid punishment—and intrinsic motivation—engagement because it is personally satisfying and unrelated to the external reward or punishment they might receive.[64] The vast amount of research that has been done on the relationship between these two types of motivation and learning indicates that intrinsic motivation is of particular significance to sustained student learning. Intrinsic motivation is enhanced when practices promote a student's sense of personal autonomy, when they feel supported and safe, when their school work is challenging but also relevant to their lives and when it builds on their experiences.[65] However, in science classroom environments throughout Nigeria, girls are often actively discouraged from engaging in science subjects and activities, their self-confidence is eroded, and very little is done to enhance their motivation to pursue science.

A student's experience in the classroom—interactions with the curriculum, teachers and peers—has a strong effect on her engagement and learning in a subject.[66] In some science classes the interest, motivation and achievement of boys is enhanced, while females experience discouragement due to factors related to curriculum, instruction and assessment.

Science textbooks in many countries have been noted for their male bias and frequent use of gender stereotypes.[67] This bias is reflected in the narrative structure, images, examples and topics used in the texts and their related classroom activities. A commonly noted bias is the portrayal of men as "active" in the generation and application of science, while females are portrayed as "passive" and occupying subordinate positions.[68] Contemporary and historical examples of the contributions of women to modern science and local scientific knowledge are often excluded from the textbooks used in African countries.[69] Examples of local scientific practice and indigenous knowledge production in which females are directly involved are even more likely to be absent.

Girls' dissatisfaction with the way in which science is presented in the classroom has a negative impact on their interest in the subject.[70] Curricular materials often fail to show the link between biology and other subjects or to emphasize the social and societal connections with science. Studies have shown such connections are of interest to both boys and girls, with girls particularly drawn to topics that involve helping others.[71] Yet despite efforts in some countries to address these biases, they persist. The problem is further aggravated in schools that rely on old textbooks and countries that lack the publishing capacity or resources to develop curricular materials that are more appealing to both girls and boys in a social context.

Teachers play an influential role in schools and act as a primary source of gendered messages received by students. The majority of time at school is spent with teachers, who are responsible for curricular and organization decisions and hold a position of authority relative to their students. And the lack of texts in many rural schools means that the role of the teacher is all the more important.[72] However, in many countries teachers have a tendency to give boys more

feedback than girls, call on boys more often, give them longer time to answer, and more frequently ask them higher order questions than they do girls. Praise, encouragement and feedback are more often directed to boys. Interactions with girls tend toward social, nonacademic topics, and girls are less frequently called on to help with demonstrations or experiments.[73] Science has also traditionally been taught in a more competitive and teacher centered manner, which has tended to dampen girls' interest in STEM.[74] Similar to findings elsewhere, studies in Nigeria reveal that girls are given less time than boys for a task in science classrooms, and boys are generally given more opportunities to ask and answer questions, to use equipment and learning materials, and to lead groups.[75]

Studies of African classrooms—though few in number—reveal entrenched gender inequities from very early grades.[76] For instance, an ethnographic study in Liberia showed differences in girls' and boys' confidence (a pattern observed around the world), with boys believing they were smarter and receiving better grades than girls. The same study revealed that girls were less verbal in fourth grade than they were in first grade; by fourth grade, they were also called upon less often, volunteered less frequently and preferred to write responses on the board.[77] A Guinean study similarly showed reduced teacher–student interaction from first to fifth grade and a related decline in girls' confidence.[78] A more recent study of primary school teachers in Benin revealed that the majority of teachers surveyed believed that science was less important for girls, given their future roles, and classified subjects according to the gendered divisions in society. Also, the belief that girls had weaker academic abilities when it came to science influenced how primary school teachers taught.[79]

Teachers' own experiences with science education can have an effect on their students. Women teachers, who are often concentrated at the primary school level, may have negative attitudes toward science acquired from their own school experiences. Such attitudes are easily transmitted to their students from an early age, making it difficult to foster interest or provide a strong foundation of learning in science for girls.[80] At the postprimary level, fewer women than men select science and mathematics as their teaching subjects, a phenomenon that both perpetuates the belief that science is not for girls and that fails to provide positive role models for female students.[81] This is reflected in the teaching subject selection of student teachers at Tai Solarin University in Ogun State in Nigeria, the first university of education in Nigeria (table 4).

TABLE 2. SELECTED TEACHING SUBJECTS OF UNDERGRADUATE STUDENT TEACHERS IN THE COLLEGE OF SCIENCE, INFORMATION AND TECHNOLOGY AT TAI SOLARIN UNIVERSITY

Subject	Number of Men	Number of Women	Percent Female
Biology	92	259	73.8
Computer science	285	210	42.4
Information and communication technology	162	97	37.5
Petrochemical science	236	98	29.3
Health education	105	224	68.1

Source: Tai Solarin University, "University Student Enrolment per Department, 2011-2013," (Ijagun, Ogun State, Nigeria: Office of the Registrar, 2013).

A total of 63.8 percent of all undergraduate students at this university, all of them training to become primary and secondary school teachers, are women. However, in the College of Science and Information Technology, which is responsible for training science teachers, men outnumber women, more than two to one in computer science, information and communication technology, and petrochemical science. Women are represented in proportion to their overall enrollment in health and education, and slightly overrepresented in biology. Women make up only 18 percent of lecturers in this college.[82]

The style and kind of assessments used by teachers can also be a source of gender bias. Some evidence suggests that boys perform better than girls in competitive, high-stakes tests. For example, in some contexts risk taking is not encouraged in girls, making it more likely that they will leave blank those multiple choice questions for which they are not sure of the answer.[83] Contributing to this is the tendency for boys, on average, to have greater confidence in their abilities and science knowledge than girls. However, when tests include a diversity of question types—such as short answers, problem solving, and multiple choice—the differences in girls' and boys' achievement narrow.[84] How assessments exacerbate gender disparities in performance in science remains an area requiring greater research. A recent review of the gendered dimensions of teaching and learning recommends that equitable learning outcomes for girls can be promoted through the use of continuous assessment and that the value of international assessments for informing national policy on learning outcomes can be enhanced if a specific gender focus is included.[85]

From this review of factors contributing to the science gender gap, it is evident that access to basic education is crucial but not enough to ensure girls' participation in and learning of science. Due to the gendered processes of socialization that occur in the home and wider society, there is a tendency for boys to have an environmentally induced head start in science.[86] The gendered biases, expectations and stereotypes that children confront at an early age can either be powerfully reinforced or challenged in school. Moreover, how science is taught can either serve to engage girls—as well as boys—and foster their interest, or can worsen both negative attitudes toward science and a lack of self-confidence. In this regard, high quality and equity in science education are complementary and need to be established from the start. Interventions to support girls' learning in science must begin at an early age, when the skills and knowledge fundamental for future learning are being acquired, and before gender disparities are cemented.

RECOMMENDATIONS FOR SUPPORTING GIRLS' ENGAGEMENT AND LEARNING IN SCIENCE IN NIGERIA

Improvements in girls' performance and participation in science over the past three decades in some countries indicate that efforts to address gender disparities have had a positive effect, although this has not been systematically studied through tracer studies and impact evaluations.[87] Ideally, a combination of strategies should be employed that take into account the local context and the specific barriers facing different populations of girls. The recommendations presented here focus on six areas for advancing girls' engagement and learning in science in Nigeria, with particular emphasis on the primary school level:

1. Improving data quality and accessibility.
2. Incorporating gender equity into teacher education.
3. Using storytelling to enhance learning and interest in science classrooms.
4. Building on STEM initiatives in Nigeria.
5. Women helping women in Nigerian science.
6. Enhancing partnerships to promote girls' participation in science.

Improving Data Quality and Accessibility

There is a serious need for more, better quality, and readily accessible data to track trends and progress. Sex disaggregated data are difficult to obtain in Nigeria on students' enrollment and performance in science at all levels, and also on the number and distribution of science teachers throughout the country. Participation in regional and international assessments would similarly aid in monitoring trends and the impact of interventions, although a more specific focus on gender within these assessments would be preferred. Inconsistent and unreliable data for assessing gender equity in science reflects a lack of recognition of the importance of the issue. In turn, the lack of relevant data means that statistics are not available to document and track the problem, thus perpetuating the issue's lack of visibility.[88]

Incorporating Gender Equity into Teacher Education

Given the influential role of teachers in students' learning, concerted action is needed in Nigeria to address gender inequities in teaching, to improve teachers' attitudes toward science in general, and to encourage more women to go into science teaching.

The lack of gender sensitivity training in teacher education in Africa is a widely noted problem.[89] Teacher education programs in Nigeria need to provide teachers with training that will build the capacity to recognize gender biases in school settings and to address gender inequity in their teaching of science specifically. In the first instance, this requires enhancing the self efficacy and sense of self worth of teachers, particularly female teachers. The low status of the teaching profession, which is sometimes viewed as a career of last resort, runs counter to teachers viewing themselves as agents of change. An approach is needed, therefore, that empowers teachers so that they can in turn empower their students to challenge prevailing views. Building capacity to take effective action also demands that actual practice in using gender equitable teaching methods need to be included in such training.[90] For example, while collaborative activities have been shown to foster learning in

science and to benefit girls, evidence also suggests that there needs to be an awareness of those inequitable behaviors that are likely to come into effect. Boys may be more likely than girls to adopt the role of leader, to manipulate equipment, and to ignore girls or dismiss them. Without active encouragement, girls often take on passive roles.[91]

Because of ingrained cultural biases and the level of capacity building that is required to counter prevailing patterns of socialization, gender equity training is unlikely to be successful as a one-time workshop. For this reason, it is recommended that such training be included as a full course or mainstreamed component of preservice teaching and be regularly offered as a part of in-service teaching. What is required is for a gender equitable approach to teaching to be explicitly integrated into classes on both content and pedagogy.[92]

To kick start and support this process, it would be beneficial to work closely with a core group of teacher educators and both preservice and in-service teachers who are committed to promoting girls' participation in science, and who thus could engage in a process of action research, documentation and reflection as they put gender equitable practices into effect in their own classrooms.[93] The lessons learned could then be incorporated into the gender equity training provided for all teachers. This would build on local experiences and enhance the quality of the training provided. The core group could then mentor other teachers—and, if successful, the model could be replicated in other institutions and geographical areas.

There is also the need to improve attitudes toward science among female teachers and to increase their interest and capacity in teaching science. To do this, it would be helpful to have incentive programs and career counseling that would encourage women to go into science teaching, to provide in-service training and support in science content, and to encourage mentoring and networking among science teachers through professional associations. The use of storytelling, games and other engaging teaching methods could potentially also have the effect of increasing teachers' interest in science education. Ultimately, the positive impact that female teachers can potentially have on girls' learning is dependent on teachers receiving adequate gender training as well as on the quality of their overall education as teachers, neither of which has received adequate attention in Nigeria.[94]

Storytelling: An Intervention for Supporting Girls' Learning and Interest in Science Classrooms in Nigeria

Giving increased attention to learning provides an opportunity to attend more closely to what occurs in Nigerian science classrooms and how the quality of science teaching can be improved to better serve girls as well as boys. Several practices are considered to promote equitable learning environments for girls and to have a positive impact on their continuation in studying science. These involve adapting classroom science to make it more engaging and interactive, encouraging relational and collaborative learning, and presenting science in a way that emphasizes social and societal connections.[95] Also of importance is starting early in girls' academic lives before they lose interest and confidence. It is with this in mind that introducing storytelling into science classes in Nigeria is proposed, beginning with the primary level.

With the growing consensus that strengthening girls' interest in science is as important as ensuring that they perform well,[96] the value of storytelling in science education has received increased attention in recent years.[97] Research suggests that stories trigger responses in the brain in ways that simple lecturing may not: Thus, storytelling activates the brain beyond mere word recognition, as similes and metaphors trigger the brain's sensory lobes, and action words stimulate the brain's motor cortex.[98] Research has likewise shown that stories stimulate the brain, even changing how we behave and potentially make life decisions.[99] There is also a growing recognition of the role that storytelling can play in integrating insights from different disciplines and in relating classroom learning to the outside world.[100] Moreover, storytelling is an intervention that can effectively draw on local materials and concepts for primary science instruction.

Unfortunately, in Nigeria, as elsewhere in the world, most students have their first introduction to science through lectures in which teachers dictate facts and information, and from assigned textbook reading that does little to engage students' interests. The traditional mode of science education is further undermined by large classes, by teaching undertaken with the primary aim of passing standardized exams, and by an overburdened curriculum that restricts the time allotted to each topic.[101] Telling stories, however, is among the easiest interventions to introduce into science classes. If science were taught through the lens of stories, teachers would not only build on girls' strengths in verbal skills but also engage the interest of all students.[102]

In the Nigerian context, storytelling has the added advantage of building on local traditions. In most communities in Nigeria, people of all ages participate in formal and informal storytelling as a form of interactive performance. In local communities, a child's traditional indigenous education includes training in the oral arts, and participation is an essential part of communal life.[103] Storytelling is among the oldest means for transferring knowledge to future generations, but its use in formal schooling has been limited.[104] This is a lost opportunity to enhance the understanding of scientific concepts by weaving in local and indigenous stories, introducing issues and concerns related to students' local context, and highlighting women's contributions in this area.[105]

As a part of its educational efforts, storytelling is used to a limited extent in Nigeria to enhance preschool children's literacy and reading skills; for example, with the national television programs *Sesame Street* and *Sesame Square*.[106] However, though language classes and textbooks use stories to teach grammar and comprehension, stories are rarely used in science textbooks or classes. Stories can be shared orally by parents and teachers, read by children themselves, and (where feasible) developed into digital stories. The possibility also exists for developing accompanying games that use local materials or are converted to digital form. There is a need to pilot such materials in primary school classrooms in Nigeria, as well as evaluate their impact on girls' interest and learning in science, so that their use can be scaled up if successful.

As a pilot storybook for such research, *The Lost Soil* tells the story of a community's struggle with soil erosion (box 6). A horrible rainstorm causes bad flooding in the town of Anambe, leading to erosion and the stripping away of the farmland,

Box 6. An Excerpt from *The Lost Soil*, by Adefunke Ekine

No one in Anambe was more heartbroken than Adaku, the tortoise's daughter. For many years, she had studied very hard in history, mathematics and science so that she could lead the school's trivia team. Every year, all the schools from every community in the state gathered together for the competition. Adaku's team had been practicing for months in preparation. But because of the horrible condition of the roads, Adaku and her team could not travel outside of Anambe to go to the state competition. Tears flowed down Adaku's face like rain on that day.

The whole town suffered, because their children could not compete and bring pride to their community. Many people believed that an evil spirit lived under the land and was troubling the people through excessive flooding to carry away their farmland and houses. Adaku wanted to find out the truth, so that she could stop whatever was bringing such hardship on her community and attend the trivia competition next year. So she called a team meeting, and her teammates discussed what they should do to find answers.

They decided to go and look for Mazi Okonjo, a very old teacher who had travelled to many lands. Mazi Okonjo had read more books than anyone in Anambe, so Adaku thought he might be able to explain the flood eating up their lands. Because of all he had read, Mazi Okonjo seemed to have a solution to every problem. For several days, Adaku and her team asked the people of the town where Mazi Okonjo lived, but no one knew. Finally, another teacher who used to work with Mazi Okonjo told them that he now lives in a cave on the edge of Anambe where he is surrounded with many books. After a day traveling across many farms and villages, Adaku and her team finally found Mazi Okonjo in his cave reading an encyclopedia.

The story continues with a dialogue in which Mazi Okonjo tells Adaku and her teammates about the causes of erosion and what steps they should take to restore their land. The wise teacher tells the children that an evil spirit did not cause their hardship, but rather heavy rain and wind. He explains that the most fertile part of the soil, the topsoil, had been washed away along with all its nutrients. The children were very eager to learn how to prevent erosion so that they could compete in the trivia competition the next year. Mazi Okonjo explains that the main cause of erosion is the removal of vegetation from the land. When trees are cut, forests are burnt, the land is cultivated for a very long time, or animals are allowed to graze the land for too long, the soil becomes exposed. It is easy for wind and water to carry the soil away without enough vegetation. He instructs the Adaku and her team to plant more trees and replace the vegetation, as the trees and their roots will help the soil stay strong against water or wind erosion.

The trivia team then returns home and mobilizes the community to plant trees and clean up the debris from the erosion. They warn the townspeople about the harmful effects of bush burning, excessively cultivating the land, and the improper disposal of waste. Soon, farming and trading returns to Anambe and the town flourishes again. Adaku and her team begin practicing for next year's trivia competition and continue to teach the townspeople about preventing erosion.

bridges and roads. The main character, Adaku, is the leader of the town's school trivia team and takes the initiative to learn how to stop erosion so the town can thrive again. The story is told in such a way that Nigerian children will be able to relate to it and learn about environmental stewardship, without excluding either boys or girls from the learning process.

Building on STEM Initiatives in Nigeria

While there is an absence of national policy or specific objectives for addressing girls' limited participation in science, several initiatives in Nigeria over the years have sought to promote and improve Science, Technology, Engineering, and Math (STEM) fields of study more generally (box 7).

Box 7. Types of Initiatives in Nigeria to Improve STEM Education

Career Days
Career days are set aside periodically in schools to expose students to the career choices available in the many fields of human endeavor, including in science. The medical field is often well represented at these fairs, which draw on local experts to come in and talk with students. Career days usually target senior secondary students in their final term of school.

Science Fairs and Quizzes
The Science Teachers' Association of Nigeria, a nonprofit association of STEM teachers, organizes annual science fairs and quizzes at the state and national levels for both primary and secondary students. These fairs, although not specifically targeted at females, encourage the production of science projects. Prizes are awarded to those with the best projects.

Information Campaigns
Many states in Nigeria organize information campaigns on scientific and technical occupations to familiarize students and their families with the range of careers and jobs in these fields. In a few states, these campaigns have reached the broad public through intense media coverage.

Televised Competition
Large, nationwide, government funded projects—such as the Junior Engineers, Technologists and Scientists (JETS) initiative—seek to make science fun for young learners. JETS began in 1982 for science students in secondary schools. The competition starts at the zonal level, the winners of which proceed to the national level and compete in front of a televised audience. Other televised competitions, such as the Mathematics Olympiad organized by Promasidor Quality Food Products (COWBELL) in collaboration with the National Mathematical Centre in Abuja, also run and are popular among young audiences.

Clinics and Academic Support
Science, mathematics and technology clinics for girls in specified institutions and locations in Nigeria have reached an advanced stage of planning, although they have yet to be implemented. The clinics are designed as a comprehensive, multiphase interventions aimed at increasing the number of females prepared at the school level to enter science and engineering studies.

Awards and Scholarships
There are a few isolated scholarship awards available for girls in science. One of note is from the Association of Professional Women Engineers of Nigeria, a subgroup of the Nigerian Society of Engineers that notes the discrimination that women face in engineering, and therefore offers a scholarship at the junior and senior secondary school levels. Scholarships are also awarded by the government at the state and federal levels to both boys and girls for the study of STEM subjects at the university level. An example of this at the university level is the Petroleum Technology Development Fund under the Ministry of Petroleum, which provides scholarships to high performing undergraduate and graduate students in engineering, geology, science and management.

There is an opportunity to build on these initiatives to target girls and engage them in science at the primary level. This could be done by:

- *Adopting a gender equity focus in career days, science fairs, competitions and information campaigns.* Career days should target girls, bringing in successful women across various disciplines as speakers, and counselors should be trained to encourage girls to explore fields in which they are underrepresented. Science fairs can actively reach out to girls, incorporating the work of female scientists and educators, and demonstrating the relevance of science to girls' lives and the importance of their participation.

Encouraging collaborative engagement in science and expanding the kinds of programs offered is also important to make STEM interventions more inclusive. Competitions and quizzes, while appealing to audiences, are not the best means by which to encourage the participation of girls and other students who may lack confidence in science. Information campaigns should also be designed with girls in mind to address the cultural biases that affect girls' participation in science.

- ***Including the primary school level in such activities as science fairs and extracurricular activities.*** Given the evidence that interest in science is often sparked at this age and influences future participation, it would be a lost opportunity not to engage girls and boys in these activities. Information campaign strategies should also take into account the need to reach young audiences.

- ***Ensuring that clinics, academic support and enrichment programs do not replicate the same gender inequitable practices as formal classrooms.*** These learning opportunities outside the formal classroom should incorporate principles of collaborative and interactive learning that have been shown to enhance understanding, knowledge and engagement for girls and boys. They should also be used as spaces in which gender equitable teaching can be practiced and shared.

- ***Targeting a broader population of girls.*** Unless a purposeful approach is taken, the girls who will benefit from the existing STEM initiatives will be those who are already participating. While supporting this group is a valuable first step, more targeted efforts need to be made to reach a broader population of girls, particularly those from poor and rural households who are most marginalized.

- ***Going beyond raising awareness to challenging gender biases and gender disparities in science education.*** While awards and prizes have brought recognition to the achievements of females in science, and are very important, more needs to be done to critically examine inequitable practices in science classrooms and workplaces. Those women and girls who have succeeded in their science fields may be effective ambassadors for change.

- ***Engaging professional societies and institutes.*** There are a large number of professional institutes and associations in Nigeria related to science, including the Nigerian Society of Engineers and the Science Teachers Association of Nigeria, but there are also many others, such as the Nigerian Nurses Association, the Nigerian Institute of Science Laboratory Technology, the National Association of Nigeria Nurses and Midwives, and the Chemical Society of Nigeria. These groups may provide a ready group of volunteers and champions for initiatives that engage girls in science.

Women and Girls Helping Girls in Nigerian Science

Mentoring and role modeling are powerful, yet they are underutilized in Nigeria. Many researchers agree that these types of interventions are important for supporting female participation in science from the early grades and throughout a woman's career in the sciences.[107]

Role modeling can be a powerful strategy in both mitigating the effects of gender stereotyping of occupations and in increasing gender equality (box 8).[108]

Box 8. "Role Model Readers" in Zimbabwe and an Example of a Nigerian Female Scientist as Role Model

In Zimbabwe, one study analyzing the effects of a role modeling booklet on primary school aged girls' career choices showed that girls respond to female role models in careers that are dominated by men. The booklet features real stories of successful women in careers where men are overrepresented. The study showed that, of the 45 girls in the treatment group who read the booklets, 73.3 percent changed their original career aspirations to from careers where women are overrepresented and are often gender typed —including teaching, nursing, and being a secretary—to careers that are dominated by men, including medicine, engineering, and aeronautics.[110]

Francisca Nneka Okeke, a Nigerian female scientist and a professor of physics at the University of Nigeria, is one such role model. She recently received the L'Oreal–UNESCO for Women in Science Award for her significant contributions to the understanding of climate science. She was also the dean of the Faculty of Physical Sciences at the University of Nigeria from 2008 to 2010. In an interview with UNESCO, she discusses the challenges she has faced as she has pursued her career in science, both from traditional sociocultural beliefs and institutional practices favoring men. She explains how, once she was appointed dean, she was instrumental in employing more female staff and encouraging younger girls to pursue careers in the field. She then suggests ways to encourage girls in science education starting early, such as providing guidance counselors, informational campaigns and mentoring.[111]

Mentoring is a powerful intervention strategy that can have positive cyclical benefits for all parties involved. Studies have shown that mentoring programs between secondary and primary schools can lead to improvements in students' academic performance, attitudes and self-confidence, while mentors also report learning from their mentees.[109] Secondary school aged girls who enjoy science subjects could serve as mentors for younger girls in primary school. Younger girls are likely to respond positively to slightly older peers to whom they look up. Similarly, female scientists could serve as mentors for girls of university age, who could serve as mentors for girls in secondary school. These layers of mentoring can benefit both the mentors, as they develop leadership skills and receive advice and encouragement, and the mentees, as they learn from someone who has faced similar obstacles relatively recently.

Strengthening Partnerships

Gender equity in science education requires greater attention, with respect to both global access and the learning agenda.[112] Promising programs need to be scaled up to reach a broader population of students. Attention also must be given across the lifetime of learning. If scientists are not born but made, increasing the number of women in science must be a long term process that requires early and sustained attention. To do so, there is much to be gained from strategic coordination and partnerships between international donors, private corporations, civil society and the government of Nigeria in implementing innovative programs.

Scientific and technological skills are of direct interest to many private corporations, which require a skilled labor force. There are examples throughout the world of STEM programs and of girls involved in science who are supported by the private sector. In Nigeria, as well, several initiatives have been undertaken in this area, but much more can be done to incorporate gender equity into the strategic focus of these programs (box 9).

There is also great potential for partnership with civil society organizations in support of girls' participation in science. The contribution of

local organizations is vital in order to extend efforts beyond the school environment, and thus to involve parents and mobilize communities in challenging the prevalent cultural biases against girls. These efforts could include media campaigns (e.g., radio programs that incorporate stories with female role models) and cultural forums (e.g., theater and arts) to raise awareness about the importance of female participation in science. Community based science projects that highlight the relevance of science to local communities and programs that link schoolchildren with community members who are knowledgeable about indigenous scientific practices—including women—can also enhance science learning for girls and boys.

Box 9. Examples of Donor and Private Corporation Initiatives in STEM Education in Nigeria

Here are several examples of important initiatives that have been introduced to facilitate girls' access to scientific and technological knowledge:

STEP-B Project: The World Bank-funded Science and Technology Education Post-Basic (STEP-B) Project distributed $200 million for science and technology projects in Nigeria between 2007 and 2013. The goal of the STEP-B Project was to improve federal post-basic science and technology education and to support the research subsector in Nigeria to produce more graduates and higher quality research. The project resulted in several improvements in science education at the beneficiary schools. Results include a 53 percent increase in the number of secondary school students to earn at least 5 credits in S&T subjects in national examinations and a 32 percent increase in the number of S&T graduates from post-basic institutions. However, results also show that boys benefited more from the project than girls, with a percentage increase in the enrolment of students in S&T programs of 59 percent for boys and 31 percent for girls.[113]

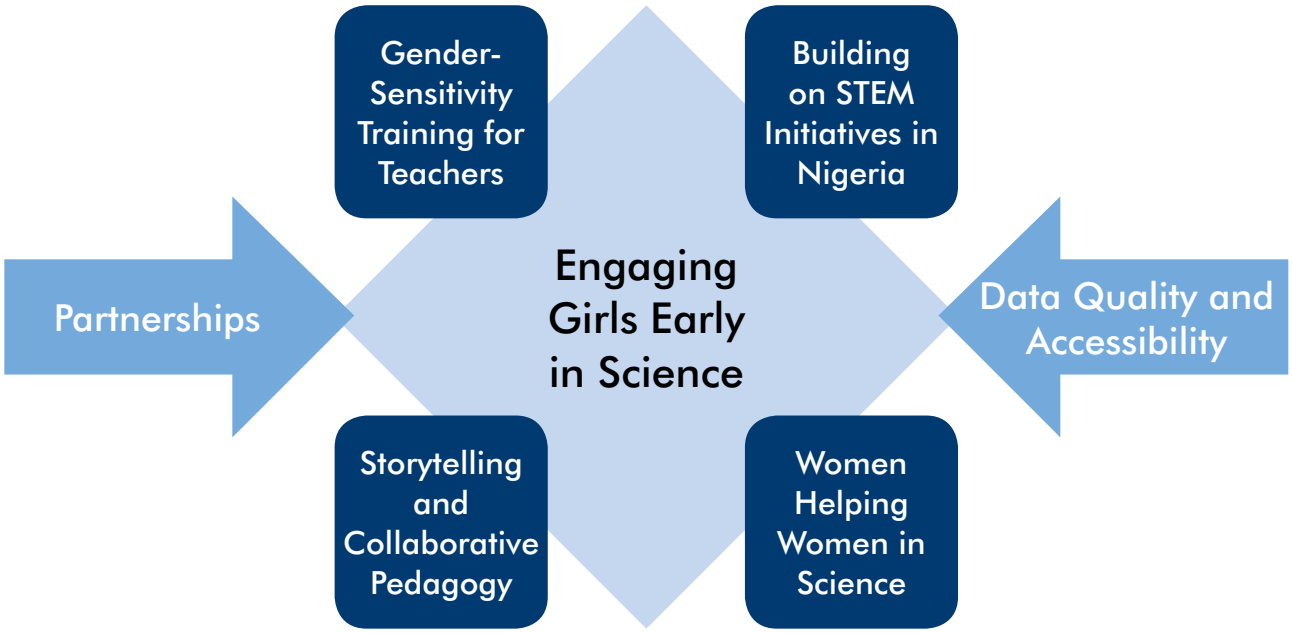
SEED: Schlumberger Excellence in Education Development (SEED) is an education program which seeks to ignite a passion for science in youth ages 10 to18 in underserved communities around the world. Funded by Schlumberger, a technology distributor for the oil and gas industry, SEED has initiated a variety of projects to enhance science education in countries where the company operates. In Nigeria, SEED has led dozens of training workshops and other events for teachers and volunteers and given financial and technical assistance to scores of schools throughout the country in order to improve internet connectivity. In 2009, SEED launched the One Laptop per Child project in four Nigerian schools. The SEED website also provides a number of interactive science resources, such as puzzles, stories, and games.[114]

SMASE Nigeria: Strengthening Mathematics and Science Education Project (SMASE) in Nigeria is a project implemented by the Japan International Cooperation Agency (JICA). SMASE aims to improve science and math education at the primary level by enhancing the skills of teachers and increasing the capability of students in these subjects. The project's implementation was designed to overcome specific challenges reported by stakeholders in Nigeria, including students' perception of difficult concepts in these subjects, monotonous use of lecture method, and inadequate teaching materials.[115] Between 2006 and 2012, SMASE led training seminars for over 11,500 primary school teachers, administrators, and policy makers involved in science and mathematics subjects.[116]

Exxon Mobil Education Initiatives: Mobil Producing Nigeria (MPN) has initiated several programs which aim to increase secondary students' interest and tertiary students' access to science education. MPN awards 500 undergraduate scholarships annually to students in Nigerian universities. Approximately 60 percent of the scholarships are awarded to students in the core disciplines of Engineering and Geosciences, and the remaining 40 percent are awarded to students in other approved business and social science related studies. The scholarships cover one year initially but are renewable based on academic performance. MPN also sponsors the National Quiz and Project Competition organized annually by the Science Teachers Association of Nigeria (STAN). MPN also sponsors a special Science Quiz Competition among 365 public and private secondary schools in Akwa Ibom State, which is then aired on the radio for six months.[117]

CONCLUSION

Figure 1. Recommendations for Enhancing Girls' Participationin Science in Nigeria



Many pressing issues confront education in Nigeria. The North of the country, in particular, lags behind in most indicators of access and retention, revealing serious challenges for the equitable provision of education for all. Nigeria has, however, over 20.5 million children enrolled in primary school and over 9 million enrolled in secondary school.[118] The quality of what these children learn is of great consequence and serves as a pull factor that will bring children to school and keep them in school. In particular, learning in science builds cognitive and noncognitive skills in students that are invaluable for both their individual lives and the development of society as a whole. However, science is the area with the greatest gender disparities in most African countries.

This paper has offered key recommendations at the level of policy and practice to improve gender equality in science education. A contribution of this paper has been to emphasize the importance of targeting girls at the primary school level, when fundamental knowledge and skills are being acquired, when interest can be most easily sparked, and when the greatest numbers of both boys and girls are in school. Recommendations that target use of data, teachers, classroom practice, STEM programs and partnerships can address many of the key barriers to girls' participation and success in science. These practical recommendations, which are summarized in figure 1, can lead to marked progress in engaging girls in science. And by confronting the issue of the science gender gap for girls, Nigeria can also improve the quality of learning and participation for boys.

Nigeria now has the opportunity to advance national development and social equality by taking action to increase girls' and women's participation in science and technology. By taking bold action, the country will demonstrate its commitment to learning across all subjects and to gender equality in all domains, and will set an example for countries across the region.

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