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Social Influence on the Enrollment of Female Students in Physics in Ugandan Educational Institutions

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Abstract. Uganda has nine operational public universities offering degrees in sciences including physics. Only four of these universities offer graduate-level physics degrees. In this paper, we examine the gender gap in enrollment of students in physics over the past five years, which later translates into occupations in physics and STEM fields in general in Uganda. Generally, the total number of students studying physics is low compared to those studying other subjects, and very few of these physics students are female. Likewise the number of female academic staff is very low, and even these few have low qualifications compared to their male counterparts. The factors influencing gender disparity in physics at universities examined include gender roles, social perception, and gender-irresponsive pedagogical approaches. The current ongoing government interventions and other strategies that can be employed to narrow the physics gender gap highlighted are reviewing of curriculum to make it more gender responsive, increasing opportunities in physics and mindset change of the teachers and the local communities.

INTRODUCTION

Women in Uganda constitute about 51% of the country's population [1]. The full participation of women in science, technology and innovations and leadership is crucial for the country to achieve the United Nations' 17 sustainable development goals.

Despite the overall improvement in the enrollment of females in universities, female students continue to be underrepresented in physics and other STEM (science, technology, engineering, and mathematics) subjects in Uganda [2]. For instance, women represented only 31% of the STEM students on the provisional admissions list for the degree programs of Busitema University, and yet Busitema University has affirmative action mechanisms where each gender competes for the admission slots separately.

CURRENT STATUS OF PHYSICS IN UGANDA

Figure 1 shows admission statistics to the physics courses in four universities from 2016 to 2020. The numbers of women admitted are very small, and while there is little statistically significant change in the number of admitted physics students, the overall number of students admitted into STEM fields has increased. New academic STEM programs (e.g., computer science and information technology) may be more attractive to students than physics, resulting in higher levels of enrollment. Most women in Uganda with advanced degrees in physics find employment at universities, teaching and conducting research. Very few take jobs in industry or at government research institutions. The majority of those with only a bachelor's degree find employment as teachers in secondary schools; a few take jobs in government or at private firms.

Women in Physics
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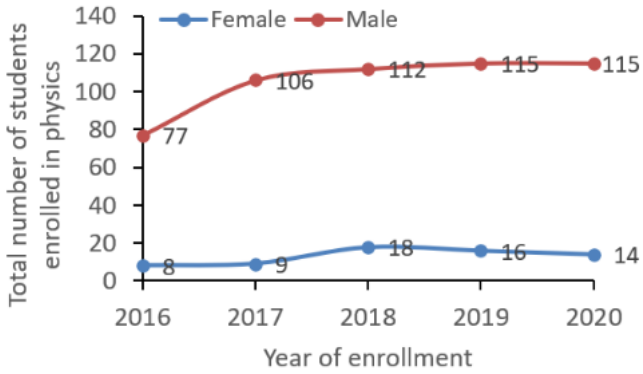

FIGURE 1. Enrollment of physics students by gender, 2016 to 2020.

The participation of Ugandan women in physics careers is influenced by the number of female academic staff in universities and high schools in Uganda. Another factor is related to their level of education. There were fewer female staff than male, and their level of education is relatively low. We collected data on the highest qualifications of physics staff from four public universities and found that only 8 out of 30 (26.7%) staff were female. Of the women, only 4 had PhDs and 4 had master's degrees. Of their male counterparts, 14 had PhDs and 8 had master's degrees. We did not include in this study some universities that have no female members of the physics staff.

A head of department or a faculty dean in Uganda must be at the rank of senior lecturer, meaning they should have taught at university level for three to five years, obtained a PhD, and made a number of publications. Similar requirements, and sometimes more, must be met to apply for research grants and participate in research actives. Therefore, female physicists will continue to be disproportionately underrepresented unless affirmative action is taken.

FACTORS INFLUENCING FEMALES ENROLLING IN PHYSICS IN UGANDA

The key determinants of students' physics self-concept—their attitude towards physics and how they see themselves in relation to the subject, both now and in the future—include their experience of physics in school and whether or not their physics teacher was supportive [3].

While it may appear that female students do not enroll in physics and other STEM subjects due to lack of interest, this is just an indicator of the way Ugandan girls are nurtured and socialized [4].

Traditionally females in Uganda are discouraged from physics and other STEM disciplines by social constructions related to gender roles and gender division of labor. For example in Uganda, house chores like fetching water, collecting firewood, cleaning, cooking, washing clothes, farming to provide food for the family, etc. are considered women's responsibilities, whereas the males are socialized to handle technical roles like repairs and construction, among others. Education, training, and undertaking certain disciplines are also heavily segregated along gender lines [4, 5]. Uganda has seen improvement in the number of girls enrolling in physics, but negative stereotypes about the ability of females to excel in physics and other STEM subjects still play a significant role in lowering females' performance and their aspirations towards physics and other STEM subjects.

For example, in Uganda equal numbers of girls and boys enroll in primary and lower secondary school and study all subjects; at this level all science, including physics, is compulsory. High school students tend to specialize in about three subjects, combining science or art. At this point, the number of females in physics begins to drop, with girls opting out of physics in their subject combinations. Some girls do not go beyond high school for varying reasons. First, most girls do not perform well in physics compared to their male counterparts due to gender roles and the home restrictions (e.g., movement, interactions with others, etc.) imposed on girls compared to the boys. Second, some girls become pregnant and drop out and are mistreated as outcasts. Finally, if the family is of low economic means, boys are supported, whereas girls are regarded as a waste of resources because they will be married off to another family. The time girls spend on education also is seen as waste, because the girl should be married off as soon as possible so that the family can gain some income. Therefore, parents need to be sensitized continuously regarding role distribution at home so that girls are not overburdened. The parents and the community should guard against gender stereotypes.

Few females enter universities, and most of those do not take physics classes. Of those who study physics, only a small percentage declare physics as a major, which results in a small number of female physicists in the labor force.

In addition to lack of female role models in physics to inspire female students, another social aspect is prejudiced teacher attitudes. This stems from the stereotypical and patriarchal notions of the abilities of female students in

sciences, especially physics, which worsen an already fragile situation. The stereotypes of how girls and boys should be raised and treated at home, school, and in the professional world translate into how they are taught in the classroom. Teachers traditionally have lower expectations of and biases against female students. In some instances, the strategies used by science teachers, especially in co-educational schools in the educational process tends to empower boys much more than girls, creating different experiences each group. To empower female students, teachers can arrange classroom seating to promote equal participation from girls and boys, enforce anti-bullying policies (including zero tolerance of classroom harassment), and encourage the participation of girls in traditionally male sports. The teachers can also organize a schoolyard clean-up day to challenge students to understand that caring for the environment is everyone's responsibility and not determined by gender. Above all, teachers should convey a gender-sensitive hidden curriculum, which can be a positive force for change. Teachers should be thoughtful about their own stereotypes and biases, as well as those represented in their teaching materials. Because Uganda is a patriarchal society, teachers need to perceive males and females equally, which is crucial to both their relations with students and the students' academic outcomes. The prevailing tendency of teachers to respond unfavorably to female students in physics largely impacts the girls' attitudes, interests, persistence, and their achievement in STEM fields [4, 6].

The gender-biased curricula in Uganda have not attracted the attention of curriculum and pedagogy experts or garnered policy interventions. For instance, textbooks portray males as doing great technical things and females as those involved in domestic and caregiving activities. The songs sung at school, especially in kindergarten, mostly portray the father as a provider and a technical person, whereas the mother is the caregiver and receiver.

As to future prospects in physics, the Ugandan government is continuously increasing the salaries of scientists and developing educational infrastructure. Another action being undertaken by the Ugandan Ministry of Education and Sports is the current ongoing review of the lower secondary school curriculum and textbooks to ensure gender-responsiveness pedagogy, among other aspects. Physics is still unattractive in Uganda in terms of career options available. The common option is teaching in high schools and universities, which may be unattractive to many women.

CONCLUSION

In Uganda, social construction is the main limiting factor for female enrollment and participation in physics and other STEM fields. Girls experience this at home, at school, and in the communities where they are nurtured. There are several key limiting factors: Gender roles that leave girls overburdened by domestic chores and caregiving responsibilities, societal perceptions that boys are better at sciences and particular physics, gender stereotyping in science, and scarcity of female models in STEM. The gender-biased curriculum and higher prospects in physics have also influence choices of female students to study physics. Textbooks, especially those in the lower grades, need to be reviewed for gender equity in both examples cited and role models portrayed. Teachers should be trained in gender-responsive pedagogy skills and teachers should be educated to recognize biases so they appreciate the current situation and trained in gender-responsive approaches. Educational institutions need to allow for mentorship programs in their schedules to inspire students, including females, in physics and other STEM fields. Hence, the government should address both the physical and social constraints that put limitations on women's choices.

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