Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #48216

BOARD # 220: Engineering Education in Ghana and the USA: Factors Involved in Successful Career Integration of Female Ghanaian Engineering Students into the USA Engineering Field

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Engineering Education in Ghana and the USA: Factors Involved in Successful Career Integration of Female Ghanaian Engineering Students into the USA Engineering Field

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ABSTRACT

The disparity in number between male and female engineering students in Ghana has been well studied, revealing that female engineering students constitute 10% - 30% of all engineering students in most college-level institutions in Ghana. Studies have also revealed an increasing migration of college graduates in Africa to the diaspora with the dream of more successful life prospects. These studies, however, fail to capture the career opportunities and challenges of female Ghanaian engineering students who obtained engineering degrees both from Ghana and the US and how differing educational settings and cultural factors may have impacted their career paths and success. This research paper seeks to investigate the factors involved in the career integration of Ghanaian women in engineering living in the USA. The study seeks to explore their preparedness for transitioning into the job market after their engineering education in both the US and Ghana, success in their work environment and overall personal satisfaction. Qualitative interviews were conducted among ten female engineering students currently pursuing advanced engineering degrees in various college-level institutions in Ghana, as well as graduates of engineering programs.

The study reveals distinct factors affecting the career integration of African women in engineering based on their educational backgrounds in Ghana and the USA. While gender representation is generally similar across both settings, the experiences of these women differ due to variations in pedagogical and curriculum structures, and the availability of mentorship and support systems. Institutional resources also play a pivotal role, as graduates from well-resourced universities generally have greater access to career-enhancing opportunities. Additionally, although many women migrate to the diaspora seeking better prospects, restrictive immigration policies can significantly impact their career advancement by limiting access to employment and professional development opportunities.

Insights derived from this study could inform educators on innovative pedagogical strategies and curriculum developments aimed at fostering better academic integration and career equitability and inspiring a more diverse and resilient workforce globally.

INTRODUCTION

College-level engineering programs in Ghana have existed since 1952 when the first college for science education was established [1]. The availability of engineering programs and the pursuit of engineering in terms of staffing, quality of education, and educational reforms is on a more developed scale than in several other African countries [2], with thousands of students from other

parts of the continent studying engineering programs in Ghana [3]. However, there remains the challenge of under-representation of females as in other parts of the world, lack of practical training and lack of opportunities post-graduation [3].

The low pursuit of engineering programs and careers by women in Ghana has been attributed to several factors. These factors include the dominant patriarchal system that existed in colonial and post-colonial times [4], the undervaluation of women's potential to pursue engineering programs and the perception that women are being forced to "compromise their femininity" by pursuing traditionally male-dominated fields [5].

The motivation for pursuing engineering and other STEM programs in Ghana has been found to include the availability of job prospects and motivation from parents and educators [6]. However, advancement of engineering education in Ghana has been hampered by lack of funds and motivation for research and limited government policies for the improvement of technological improvement [2]. Another persistent problem in the engineering industry in Ghana is the lack of post-graduate job opportunities. It has been reported that only about 10% of college graduates in Ghana secure jobs right after graduating [7] due to the country's low economic growth and limited job market. There is also an identified disconnect between the skills acquired in school and the relevant revolving needs of the industry, stifling innovation and resulting in the inability to secure employment opportunities [8]. Additionally, there is limited education and support for entrepreneurial initiatives, which could encourage business startups [9]. Many engineering students also lack proper guidance in transitioning into and navigating the job market properly, including help with resume writing and interview preparations [10].
Due to these challenges, there has been an observed increase in the migration of African students to the diaspora for better career prospects after completing their undergraduate education. It has been reported that migration of Ghanaian students into the USA has seen an all-time high in recent years, with an increase of more than 30% between 2022 - and 2023 [11].

Studies have investigated the experiences of African-born students in STEM majors, specifically in the USA, highlighting issues of identity crises and community belongingness [12]. A limited number of studies investigating the overall experience of engineering African Diasporan students studying in the US gathered the key perspectives on the differences diasporan students experienced regarding delivery of instruction in class, mode of assessment and workload [13]. However, specific studies on how these experiences impact the academic integration and long-term professional success of female migrants from Ghana studying engineering have yet to be thoroughly explored.

To address these gaps, three main research questions were developed, as listed below:

1. What are the key factors that affect the successful career and academic integration of Ghanaian women into the USA engineering field?
2. How do these factors in the Ghanaian and American engineering programs differently impact the career aspirations and readiness of female Ghanaian engineering students?
3. What strategies for integration and transition can be implemented to enhance the career success of Ghanaian female engineers in the USA?

With these questions, this study seeks to find insights into the impact of the differences and similarities in curricula and educational resources between engineering education in Ghana and

in the USA on the career success of the interviewed women. It also seeks to discuss strategies for enhancing the academic and professional advancement of women transitioning between the Ghanaian and American engineering educational settings. In this study, the concepts of academic integration and international student mobility (ISM) served as the framework of the research method and discussions.

METHOD

The study employed a qualitative design using semi-structured interviews to gather insights, perceptions, personal experiences, and interpretations from the study participants. The interview questions were designed according to the research questions. They included questions assessing the differences in teaching and curriculum practices in both countries, and the career equitability and success of the participants. The study was conducted according to the Institutional Review Board (IRB) guidelines approved by Arizona State University.

The scope of the study was female engineering students who migrated from Ghana after their bachelor's degree. Participants interviewed attended various universities in Ghana and the USA, allowing for a range of diverse responses and perspectives. A total of 10 individuals identified using the purposive sampling method participated in the study. The study included distributed surveys as well as in-depth interviews. Surveys included close-ended and open-ended questions, and a semi-structured interview with a curated set of questions was used to allow flexibility in the interviews. Each interview lasted between 30 minutes to an hour per participant and was conducted through voice calls. Written notes and audio recordings were made to accurately capture participant responses for later analyses. The audio recordings were made using a computer recorder and then transcribed verbatim. Transcriptions were also reviewed against the audio recordings for accuracy. The themes of each interview/survey were then analyzed based on the research questions of this study. Responses to the questions were grouped under broader themes related to each research question to analyze overlapping themes for consistency and coherence.

RESULTS

Participants included doctoral students and master's graduates working in the fields of bioengineering, biomedical engineering, mechanical engineering, electrical engineering and civil engineering.

Thematic analysis of the interview transcript identified three main points of focus in this study: (1) differences and similarities in implemented structures to support successful engineering careers for women in Ghana and in the USA, (2) influence of institutional resources, (3) navigating female representation and minority status (4) external barriers that affect the personal career goals of participants, particularly ones related to immigration policies.

Theme 1: differences and similarities in implemented structures to support successful engineering careers for women

In general, participants expressed an observed difference in the availability of practical academic experience, guidance, and mentorship opportunities when comparing the two educational settings. Although the comparison between graduate and undergraduate experiences introduces certain nuances, participants offered an assessment of the general academic and professional environments across both educational settings.

Most of the participants expressed that the availability of hands-on work to supplement their engineering studies was more limited in Ghana than in the USA. For instance, one participant stated that the primary source of information was "*from the textbooks*". Similarly, another participant stated that "*There were very few opportunities to build things [in Ghana]. It was stressful even to get the materials*." She, however, expressed that virtual practical work and software use were a beneficial addition to theoretical studies obtained in Ghana.

Regarding mentorship and guidance resources, another participant remarked that guidance came informally from "friends [and] seniors from school" while she was studying in Ghana. On the other hand, she "*had an advisor from her first day in school*", indicating access to more formal support systems to help her navigate her career path while in the USA. Other participants expressed access to mentorship as an individual initiative, regardless of the location of their educational institution.

Participants also expressed the influence of the different educational systems on their smooth transition into the U.S. job market. Different factors were involved in the feeling of preparedness for the job market, such as a strong theoretical foundation in engineering obtained in Ghana, participation in projects, and the ability to navigate a new environment in the USA. Generally, participants expressed that the increased availability of resources in the USA enabled them to gain knowledge and explore different pathways in their fields of study. For example, one participant stated:

"*I have had a shift in my perspectives and aspirations since I came to the USA*."

Theme 2: influence of institutional resources even in the same country

The responses from the participants revealed the impact of institutional resources on career preparedness, even in the same country. Engineering programs in different institutions, regardless of the geographic location, offered varying support in terms of internship opportunities and entrepreneurial resources. While certain participants who studied at a particular university in Ghana expressed that there were a limited number of internship opportunities during their studies, other participants who studied at another university observed easier access to companies and jobs within Ghana for coops and internships. Certain participants expressed a comparative ease of accessing hands-on in-class activities, career guidance, and entrepreneurial resources in their schools. In contrast, others expressed that these resources were less accessible to them.

One participant from a private engineering institution noted:

"*In [Ghana]...we had more hands-on, very practical [work]... we did not wait to do our dissertation in the final year... From introduction to engineering to the last course, you are always doing group work.*"

However, a participant who attended a public engineering institution expressed:

"*We had few labs in Ghana…, general engineering labs being shared by different engineering majors*"

The differences in institutional resources also affected the job prospects of participants. As one participant described, there was a "*mentality that, if you go to [my university], you'll definitely find a job*", suggesting that certain institutions have established stronger industry connections to support student career development than others.

Theme 3:

Participants highlighted varying experiences of female representation in different educational and professional settings. One participant described that deliberate efforts were made to balance gender representation while she was in her Ghanaian institution, with some engineering programs being less male-dominated than others. However, one student from a different Ghanaian institution noted that female underrepresentation was particularly pronounced in student leadership roles.

Although gender disparities were acknowledged by participants in the USA, participants emphasized that being an international student in the US often outweighed gender as a minority concern. In that regard, feelings of being a minority were reported to be less pronounced in Ghana. A key issue raised was the limited number of female professors in the U.S. who shared similar backgrounds with participants. Some participants noted that they had to attend designated "Black student" events to connect with "*professors who looked like [her]*" who could offer guidance relevant to their careers.

Despite these gender and minority-relates challenges, participants acknowledged the presence of systems in place in the U.S. to support underrepresented groups in the engineering industry. One participant, who had comparable access to internships in both Ghana and the USA., pointed out that a significant difference was the presence of structured support and policies in the USA aimed at preventing discrimination in the workplace.

Theme 4: external barriers to career advancement, particularly ones related to immigration policies

Participants highlighted external factors beyond their control that influenced their career paths and success, with immigration policies being a primary challenge while studying or working abroad. These limitations not only limited their job prospects but also constrained their career paths to roles that were "…*accessible, rather than those that aligned with [her] interests and skills*". One participant expressed an inability to explore diverse pathways in the USA, stating that she had to "*settle for jobs in fields that were not exactly what [she] trained for*". The responses revealed that the perceived advantage of pursuing an engineering career in the USA may be hindered by limitations due to immigration policies.

DISCUSSION

The integration of student migrants into the career fields of their host countries involves navigating various cultural, educational and professional landscapes [14]. The results from this study reveal key factors involved in the academic and job success of female student migrants from Ghana in the engineering industry. These include institutional factors, social and cultural factors, personal goals, and global and structural policies (Figure 1). These factors interact to influence the career satisfaction of these women while they pursue their engineering careers.

Figure 1- Factors involved in the career integration and success of participants in this study can be grouped into key categories, as shown.

Social, Cultural and Personal Factors Affecting Career Integration

Research has shown an increase in the enrolment and completion of females in engineering education in Ghana in the past decade, attributed to policies to help advocate for women in Science, Technology, Engineering and Math (STEM). Efforts to overcome gender inequity in STEM have included raising awareness of gender bias and affirmative action policies [15]. Responses from this study demonstrate that participants observed similarities in the percentage of female representation in their studies in Ghana and the USA. A few participants also expressed efforts by their institutions to ensure a gender-balanced student population. Female underrepresentation in the engineering field is a global issue, with a noticeable scarcity of female role models at all levels in academia and industry in the USA [16]. Overall, participants expressed that there is a need to increase investment in resource-intensive education to address the differences in implemented structures in Ghana and the USA for women pursuing engineering careers.

Participants in the job industry in the U.S. noted that well-developed inclusion strategies in the workplace fostered a sense of belonging and support. These strategies, such as diversity

initiatives and structured workplace policies, helped mitigate some of the barriers women and foreigners face regarding inclusion in the engineering job industry.

The findings also illustrate the interplay between personal goals, external barriers, and internal resilience in shaping the career trajectories of female engineering students. Studies investigating the career prospects of Ghanaian women in STEM reveal that more female students are uncertain about their choice of a future career than males, due to factors such as uncertainties within the job market [6]. Respondents pursuing their Ph.D. studies indicated that they have a much broader range of research fields from which their graduate studies in the USA can be chosen. Most participants in the job industry also expressed that although there are a variety of options in their fields of engineering, they have had to choose careers based on what is available. Certain participants also expressed that they have been forced to adjust their career aspirations, pursuing trajectories that aligned more closely with opportunities accessible to them.

Institutional Resources and Global Structures Involved in Career Transition and Integration

Globally, there are specific structures necessary for supporting engineering careers, such as hands-on learning, relevant mentorship and guidance, and industry partnerships. Access to these resources varies with economic, socioeconomic, systemic and geopolitical discrepancies across nations. Studies comparing engineering education in Africa and other developed countries have demonstrated disparities in resources, educational structure and infrastructure [17]. These differences significantly impact the readiness of students to compete on a global scale for the development of the continent. Generally, participants expressed that resources necessary for their engineering education were more extensive and accessible in the USA. Certain participants expressed limited laboratory resources and practical training while schooling in Ghana. They noted that these limitations affected their ability to seamlessly transition into the US education system for their graduate studies. While Ghana boasts some of the leading tertiary education institutions, studies have highlighted challenges in limited specialization and insufficient resource availability for the engineering industry [18]. Advancement in resource availability will enable students to compete on a global scale in their careers, especially in the presence of cultural and gender biases.

Participants highlighted varying levels of preparedness for the job market, shaped by the resources, training, and opportunities available to them during their education. Analysis of the responses from women who studied in different Ghanaian institutions demonstrates disparities in accessing internships, laboratories and professional networks. This highlights a lack of equitable resource distribution for the average female engineering student in Ghana, which may be due to several factors, such as insufficient institutional funding. This may perpetuate systemic inequities, widening the gap in career progression among Ghanaian women in the engineering field on the international level. Institutional collaborations may help develop strategies for less-resourced institutions to improve the career outcomes of their students.

Additionally, participants emphasized the paradox of moving abroad for better career opportunities but facing systemic barriers, such as immigration challenges that limit access to the attainment of their full potential. Several of the participants highlighted challenges in obtaining internship and job opportunities in the US due to their immigration statuses. There have been several studies exploring the contribution of international student mobility to their home

countries, including participation in governance and politics, poverty reduction, knowledge transfer and the strengthening of international diplomacy [19]. Due to these contributions, participants expressed that there is a need to develop systems in Ghana to support student migrants in obtaining jobs across the world for global impact.

Advancing Career Integration into the US Engineering Industry

Participants suggested tools that will help the career integration of women transitioning between the Ghanaian and American educational settings. These included better inclusion of business and entrepreneurial programs in Ghana. Additionally, participants recommended that the diverse opportunities and pathways available in their fields be introduced to them at the early stages of their careers. Participants also advocated for educational and government policies related to immigration that would facilitate smoother transition across the two different educational settings. These may include the integration of global perspectives into the engineering curricula and international mobility policies. Educational institutions and policies in Ghana should advocate for more inclusive immigration policies for their international students to remove barriers that restrict career opportunities. This may be done by highlighting the economic, cultural and intellectual contributions of international graduates in filling critical gaps in STEM fields in the USA. Institutions with global reach can advocate for policies regarding work authorization, legal aid and career services to help students navigate existing immigration barriers.

Female engineers should have consistent support and guidance from other female engineers from diverse national and cultural backgrounds. Additionally, the use of standardized and adaptable approaches to train engineering students will ensure that their skills and credentials are relevant across international borders. This would prepare students for career success not only in Ghana but also promote collaboration across continents.

CONCLUSION

This study highlights the key factors that shape the experiences and career trajectories of women who moved from Ghana to the US to pursue their engineering careers. These include availability and disparities in engineering education resources, as well as mobility policies. The study underscores the need for further research to develop global frameworks in engineering education that allow adaptability and smoother transitions between different educational and professional settings as the world becomes increasingly interconnected. Future studies should also include a broader range of demographics, such as several other international students and host countries, and women at different stages of their engineering careers. This would help address the scope limitations in this study, fostering international collaborations across continents.

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