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Original Article

Exploring How Female Scientists are Uplifted in Research Networks in STEM Fields in Public Universities in Uganda

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Participation in research networks is inevitable for the female scientists in the Science Technology Engineering and Mathematics (STEM) fields because they provide a platform for collaborative activities. New research communities of women are created to support each other through mentoring, advancing shared research interests, co-organizing conferences with men, participating in the editorial and the publications. It was on this basis that this study explored how female scientists were uplifted by research networks in STEM fields in public universities in Uganda. This study was anchored on the existential phenomenology by Martin Heidegger in the interpretive world view. Eight female scientists in research networks in STEM fields in public universities in Uganda were interviewed and they were selected from the hard applied and hard pure disciplines as classified in Becher and Biglan's typology of academic disciplines. Using thematic analysis, two themes such as research collaboration activities and capacity development emerged in this study. This qualitative study set out to explore how female scientists were uplifted in research networks in public universities in Uganda. The public universities included Makerere University, Mbarara University of Science and Technology, Gulu University and Busitema University. Both semi-structured interviews and document check data generation strategies were used in this study. In semi-structured interviews, a sample comprising eight female academics with not less than five years in research networks in public universities were selected, while documents such as the annual reports and strategic plans were used. This study concludes that research networks are uplifting the female scientists in STEM fields in public universities in Uganda because they were internationally exposed, networked, funded, research skills were strengthened, and progressed in career. This study concludes that it was important for female scientists to access physical and human resource in their research networks as this increased their research performance and outputs in STEM fields in public universities in Uganda. This study therefore recommends that, to uplift female scientists in research networks in STEM fields in public universities in Uganda, female scientists in the research networks and senior colleagues should act as ambassadors and mentors to young female scientists in STEM fields.

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INTRODUCTION

Researcher networks foster collaborations with joint research projects, accelerated visibility through joint publications, presentations and professional growth to researchers. Research ties facilitate the diffusion of emergent knowledge streams, access to new research opportunities across institutional, disciplinary, and geographic boundaries (Kuld & O'Hagan, 2018). More importantly, it is a criteria for promotion in research-led universities and female scientists in research networks in STEM fields need to improve their research productivity, particularly in the refereed publications hence a justification to participation in research networks (Siciliano et al., 2018). Universities are also privileged social institutions for the education and training of high-level knowledge and skills and the production of knowledge through scientific research (Baptista & Vilsmaier, 2022). With network utilization, actors therefore evaluate whether network contacts have and may provide them with valuable resources and then solicit resources from their contacts (Khattab et al., 2020). This raises questions on how research networks are uplifting female scientists in STEM fields in public universities in Uganda. This is based on the fact that research in the field of higher education is required to address various issues, one being that of increasing female scientists' contribution to knowledge generation and visibility in academia. The public universities included Makerere University, Mbarara University of Science and Technology, Gulu University and Busitema University.

Research Question

The study was guided by the following main research question. How are research networks uplifting female scientists in STEM fields in public universities in Uganda?

RELATED LITERATURE**Theoretical Review**

This study was anchored on the social capital theory which was developed by Lin (2001). Social capital is defined as resources embedded in one's social networks and these resources can be accessed through the ties in the networks (Lin, 2001). Lin asserts that the premise behind the notion of social capital is the investment in social relations with expected returns. His theory covers both the access to social capital and the individual return on social capital. Lin argues that the social status of network members is a predictor of the quality of resources conveyed by social relations. Lin's thesis is that social resources exert an important and significant effect on the realization of individual instrumental actions. Linking social capital serves to describe the ties that connect individuals to groups in positions of political and financial power hence represents the accessible resources used for a regular action (Lin, 1999; 2001). Lin (2001) found out that there were four explanations as to why embedded resources in social networks enhance the outcomes of actions. These include information flow facilitation, the social ties that may influence the behavior of others, social ties may be seen as social credentials that reflect accessibility to resources, and being in social relationship reinforces identity and recognition. The resources embedded in social connections, the amount of those resources produced by the totality of the relationships between actors, and the quality of those resources (Lin, 2001). A researcher must have relationships with other researchers who are the source of his/ her advantage (Lin, 2001).

The social capital theory by Lin (2001) was used in this study because it captures the value of relationships, representing the resources that can be drawn from ties, solidarity, reputation, and access to

information (Lin, 2001). Lin (2001) argues that some social ties, due to their strategic locations and positions, also carry more valued resources and exercise greater power on decision making process hence capable of providing added resources beyond one's personal capital. Individuals need the help, and the support of others and reinforcement is essential for the entitlement to resources (Lin, 2001). Although acknowledged for remarkable strides in higher education, the social capital theory has been criticized for lacking uniformity regarding indicators and approaches used to measure aspects of social capital (Harper, 2002).

Empirical Review

Herschberg et al., (2018) assert that research networks across Europe, France, Belgium, and Italy have led to an increase in collaboration especially in research, publications and have influenced career progress, secured academic positions, promotions, external funding for their research and attained highly prestigious awards. Fox (2020) also affirms that female scientists in research networks in STEM fields participate more in national and institutional research networking. Similarly, research networks have facilitated academic career advancement for female scientists in research networks in STEM fields as they promote exchange of ideas, skills, and expertise in the United States of America (Zippel, 2017). This is further in line with Bonilla et al., (2021) who report symbolic recognition through local awards such as the L'oreal United Nations Educational Scientific and Cultural Organization Women in Science fellowships which makes the interaction between female scientists in research networks in STEM fields in different stages of their careers share ideas, work together, and have a sense of belonging.

The foregoing studies agree with Bonilla et al., (2018) that research networking increases their exposure, visibility of their contributions and career development. This exposure and recognition have enabled further impact on their societies as they act as role models. Therefore, it is inherent that female scientists in research networks in STEM fields indeed search for scholarships, fellowships and financial funding that is pivotal for participating in a research network. This view is supported by Kwiek

(2021) who notes that scientists from top European universities predominantly seek to coauthor with colleagues from top universities globally therefore high-performing institutions attract high performing international collaborators, leading to highly cited joint papers (Fox, et al., 2017). Cross fertilization is seen as a strategic need to ensure that institutions innovate to remain competitive in the market (González-Piñero et al., 2021). It is, therefore, a vital component to fostering research collaboration within large university departments that have multiple research teams each with their own distinct identities. Furthermore, empowering students and staff to collaborate in research also enables research to better contribute to universal goals (Rossouw, 2020). It has also gradually become obvious that differences between institutional settings need to be managed more systematically to promote cross-border research cooperation for shared benefits, from individual to institutional levels. An informed discussion of managing complex conditions necessitates an understanding of the relationship-level dynamics of research collaborations (Shih, 2023).

While the European female scientists in research networks in STEM fields seem to collaborate and co-author internationally in pursuit of academic prestige, scientific recognition, and access to research funding (Kwiek, 2021), a similar pattern was noted in Italy where female scientists in research networks in STEM fields collaborate more with international colleagues and become highly productive hence more internationalized (Abramo et al., 2019a). Conversely, it is important to emphasize that female scientists in research networks are reported to have collaborations that are more domestically oriented, have less prestigious and fewer collaborations (Aksnes et al., 2019; Halevi, 2019; Holman & Morandin, 2019; Huang et al., 2020). This is akin but not like the empirical evidence that few female scientists in research networks in STEM fields are publishing in high-impact journals (Lerchenmueller et al., 2019).

In the Ugandan context, the Makerere University's Infectious Diseases Institute established the Women Scientists' Career Development Program that aims at providing career related support, networking, scholarships and research grants, conferences to

female scientists in research networks in STEM fields as researchers (World Health Organization, 2018). The above scholarly views concur with other scholars (such as Organization for Women in Sciences for the Developing World, 2020; Quadrio-Curzio et al., 2020) who emphasized that female scientists in research networks in STEM fields are networking to improve career success through employment, publication, and conference opportunities. I recognize and agree with Balakrishnan (2018) and Mauduit et al., (2020) that exchanges and collaborative processes among female scientists in research networks in STEM fields from different parts of the world reveal empowerment of female scientists in research networks for sustainable development, scholarships, and research grants. Career-related networking can be seen as a form of resource management whereby individuals actively engage in generating social resources through networking (Spurk et al., 2019). Research professional networks for female scientists in STEM fields also reflect a greater focus on teaching and service (Kwiek & Roszka, 2020). Given the need for greater networking, the diversity in women's scientific networks promoted advancement of translational research (Felez et al., 2015). Whereas these studies make noticeable contributions and are lauded for highlighting female scientists in research networks in STEM fields being up lifted, their focus is on European and American universities. The need for a study meant to deepen and refine the understanding of the same in the sub-Saharan African context is long overdue.

METHODOLOGY

This qualitative study was conducted by adopting the interpretative paradigm aiming to gain an in-depth understanding of varied and multiple interpretations of how the research networks are uplifting female scientists in STEM fields in public universities in Uganda. The public universities included Makerere University, Mbarara University of Science and Technology, Gulu University and Busitema University and the rationale for focusing on public universities was because they had diverse demographic characteristics of the study population and more established research networks. The four public universities were selected in this study because they gave a fair geographical representation

of public universities in Uganda. Makerere University was selected from the central region of Uganda and Mbarara University was selected from the western region of Uganda. While Gulu University was selected from the northern region of Uganda, Busitema University was also selected from the eastern region of Uganda.

A total of eight female scientists were identified through purposive sampling from eight different Faculties and Colleges. While four female scientists in research networks were selected from the hard pure disciplines, other four participants were selected from the hard applied disciplines in public universities in Uganda. The selection of the hard pure and the hard applied disciplines was because these were STEM fields and they also catered for disciplinary diversity. A semi-structured interview technique was adopted whereby face-to-face interviews were conducted to generate primary data. These interviews were deemed important to get an in-depth understanding of female scientists' experiences in STEM fields in research networks in public universities in Uganda.

An in-depth analysis of how the research networks are uplifting female scientists in STEM fields in public universities in Uganda was done, and major themes included the following: International exposure, networking, funding, strengthening research skills, career progress. Secondary data were generated from the United Nations Sustainable Development Goals, African Union Agenda 2063, Uganda Vision 2040, National Development Plan III, Makerere University College of Health Sciences Annual Reports, and strategic plans of public universities in Uganda on the uplifting of female scientists in STEM fields in research networks in public universities in Uganda to reinforce the primary findings. The general procedures for preparing and analyzing the data included; making statements from semi-structured interviews, converting significant statements into meaningful themes, interpreting and presenting the essence of the study in the form of themes and categories.

FINDINGS

This study focused on how the research networks uplifted female scientists in STEM fields in public universities in Uganda. Based on semi-structured

interviews and document check, the following sub themes emerged: International exposure, networking, funding, strengthening research skills, career progress.

International exposure: Most of the participants agreed that they received international exposure from their research networks in the STEM fields in public universities in Uganda. They were exposed by meeting new people at international level and got the best facilities in their fields. For instance, participant 4 shared that:

I felt great meeting people at international level. I became an ambassador for my region in preparing regional workshops and summer school activities that were held at Busitema University.

In a similar vein, participant 3 from Busitema said that:

I count myself very blessed. I am part of that research network, and it has given me an opportunity to be exposed even to the first world countries. I got the best exposure to the best laboratories and made new friends. I do my work very differently in this university.

Networking: revealed that they networked with other scientists in the STEM fields at national, regional, and international levels. They agreed that they were uplifted and benefited a lot from the networks, increase their research portfolio, bought equipment, established their own networks, and trained young scientists in different universities in Uganda. For instance, participant 1 from Makerere University revealed that:

I have worked with big scientists and big thinkers in big networks, and I was able to see the world beyond the borders! Better still, I have served on many committees, and it has helped me to expand my networks. I network to bring in new partners in the school and I make sure that our partners are happy with us and that we deliver quality results on time. We are doing well through networking because we have a big portfolio of research partnerships and projects.

Similarly, participant 8 from Mbarara University of Science and Technology acknowledged that:

I have benefited from my regional research network where more money has been paid to me and this has opened many opportunities to buy laboratory equipment like global positioning system and microscopes for our project and the university.

Funding: Some female scientists in this study acknowledged that they had received funding from their research networks in STEM fields in public universities in Uganda. The funding which was received was in terms of the best payments, travel grants, fellowships, and research grants. In support, participant 2 from Makerere University attested that:

I have accessed funding, met, and interacted with international collaborators at both regional and local institutions. Most interesting about this, experience is that, since then every year I have kept winning grants for our university. I have won three grants for research so far and this is quite a fulfilling journey. This gave me more visibility and exposed now.

Strengthening research skills

Research networks also uplifted female scientists in STEM fields in public universities in Uganda by strengthening their research competencies. They acknowledged that they were able to supervise, write proposals, and publish as an outcome. For instance, participant 6 from Gulu University said that:

I was taken through rigorous research activities that I have mastered the art now. If it was not for this research network, I do not know. But I can now supervise quality research work at all levels.

Another participant 2 from Makerere University added that:

I have managed to get over twenty publications and these have enabled me to be promoted to the rank of professor at Makerere University, the much-desired requirement for promotion. Do you know what it feels like to be a professor in this unit and a female? I also remember, there was a time a collaborator wrote to me and asked me if I could work with them on the project. It is because of my publications that I wrote with others in my research networks. Those publications have marketed me. So, it is not

about the people you know and not luck. But it is about your work.

Career progress: Research networks also contributed to career progression of female scientists in STEM fields in public universities in Uganda. They agreed that they participated in conferences training, seminars, presentations, and workshops which had been organized by their research networks. They acquired leadership, communication, negotiation, and writing skills which have enhanced their progression in their careers in their respective universities in Uganda. For instance, participant 4 from Busitema University revealed that:

You know, international conferences provided a platform for me as female scientists to present my work. I have attended international conferences and symposiums with peers and potential collaborators, where we show cased our skills on a global stage network and this has helped me to advance in my profession.

In addition, participant 2 from at Makerere University reported that:

I have attended many serious conferences in my field. I am now the chairperson and a leader in most of these networks. My leadership skills have surely improved. In these networks, we share skills, organize seminars for mathematics camps, train and hold outreach activities for the communities. I have also supervised PhD students in mathematics at regional level because I am in those networks which are good for me in my work.

DISCUSSION OF FINDINGS

The findings in this study revealed that female scientists had been uplifted through networking in these research networks in STEM fields in public universities in Uganda.

Networking: The findings in this study revealed that female scientists had been uplifted through networking in these research networks in STEM fields in public universities in Uganda. For instance, participant 1 from Makerere University reflected that: “You are as good as the research networks you associate with. If you are associating with a research network that is so small in their reach and thinking

or dreams, then your growth can be hampered. But if you are exposed to networks that are large and transcend boundaries of institutions that transcend boundaries of countries, then you begin to know that networks and relationships in those networks matter”. It is important to have national, regional, and international research networks for female scientists because networking provides avenues for bench marking and adopting best practices from the already existing developed higher education systems. In support of the above findings, Mauduit and Soler (2020) stressed that there is proven importance of networking at local, national, regional, and international level for female scientists Organization for Women in Sciences for the Developing World -Elsevier Foundation Awards for Early Career Women Scientists reward and encourage women at the early stages of their scientific careers, who have overcome great challenges to achieve research excellence. Visibility for Organization for Women in Sciences for the Developing World work in the regions was much enhanced (Quadrio-Curzio et al., 2020).

International research: The above finding was consistent with findings that found a stronger tendency towards international collaborations among top scientists, which might earn them higher research output, visibility, and reputation (Abramo et al., 2019). Studies have also reported that men and women exhibit different behavior in collaboration practices, and male scientists are more likely to adopt effective collaborative behavior that could be presumed to lead to higher scientific productivity and impact (Jadidi et al., 2018). The above notwithstanding, findings show that women are lagging in international research, and they are generally less active at the international level (Uhly et al., 2015). Based on the complementary benefits that networking brings to the research arm of the universities such as recognition, international exposure, there is need to encourage female scientists to join research networks because of the benefits that are embedded therein. Female scientists’ collaboration networks contain more weak ties while males tend to have more long-lasting and strong ties (Jadidi et al., 2018), which are generally associated with high impact research (Petersen, 2018). There is also evidence suggesting

that scholars favor collaborators of the same gender, identified as the gender homophily effect (Holman & Morandin, 2019; Jadidi et al., 2018).

Since female scientists are underrepresented in primary disciplines, the gender homophily effect could create some disadvantages for them, such as less academic recognition, limited access to resources, collaborators, and funding opportunities (Holman et al., 2018). This could result in gender productivity gap in academia where male scholars often outperform females in research activities (Astegiano et al., 2019). The above evidence demonstrates how different collaboration strategies could affect scholars' academic performance. Even though the female scientist networks exist, participants paid attention to networking with respect to the developed world that had formal professional research networks. It may explain why the participants' views did not indicate formal networks that were locally registered and better still the female only research networks were never clearly mentioned in these public universities. So, there is now great need to seriously establish and strengthen existing female scientist research networks.

Funding: Research collaboration is also tied to large funding successes (Bansal et al., 2019). All the female scientists highlighted funding as critical in uplifting the female scientists in research networks in public universities in Uganda. Regarding funding, various forms included grants, scholarship, post doctorates, sponsorships, fellowships, and endowments that provided indispensable financial support for collaborative activities. For instance, participant 2 from, Makerere University revealed that “I have benefited fellowships right from the time I was an early career female scientist. This fellowship program has provided me with a postdoctoral fellowship development grant more than three times”. Participant 2 received post-doctoral fellowships within her research network which offered invaluable opportunities for collaborative research experiences, specialized training, and enhanced completion. Perhaps all these all contribute to the advancement of knowledge and expertise in her respective field.

Contrary to the above findings, Sato et al., (2021) observes that female scientists in research networks in STEM fields have difficulty in grant peer review and funding decisions. These systemic disadvantages that women face accumulate, resulting in lower productivity, and hence, a weaker profile that may not be sufficient for the grant scheme criteria. Put differently, female scientists in research networks in STEM fields bear the burden of discriminatory reviewer biases that identify them as being less competent. Several scholars, however, are concerned about this impact agenda on research funding. Research with less potential, which is likely to be new, would be alienated in research funding decisions or under-funded because of the impact agenda, while research with potential impact would be prioritized, even if they are equally valuable. In other words, funding allows collaborative researchers to overcome the difficulties or restrictions that come along with remote collaborations and to pursue novel outcomes. This highlights the importance of funding in science activities that not only contributes to the scientific advancement but also enhances the opportunity of novel outcome. It also allows scientists from smaller and less central science systems to connect with global knowledge production centers and with more prominent researchers (Iglic et al., 2017).

Cross fertilization is seen as a strategic need to ensure that institutions innovate to remain competitive in the market (González-Piñero et al., 2021). It is, therefore, a vital component to fostering research collaboration within large university departments that have multiple research teams each with their own distinct identities. Furthermore, Rossouw (2022) reveals that empowering students and staff to collaborate in research also enables research to better contribute to universal goals and it has gradually become obvious that differences between institutional settings need to be managed more systematically to promote cross-border research cooperation for shared benefits, from individual to institutional levels. An informed discussion of managing complex conditions necessitates an understanding of the relationship-level dynamics of research collaborations (Shih, 2023).

CONCLUSION

This study concludes that research networks are uplifting the female scientists in STEM fields in public universities in Uganda because they were internationally exposed, networked, funded, research skills were strengthened, and progressed in career. Through participation in research networks, female scientists were internationally exposed to the best scientists and facilities in their fields, increased their research portfolio, bought equipment, established their own networks, and trained young scientists in different universities in Uganda. Female scientists in research networks strengthened their research competencies as they were able to supervise, write proposals, and publish as an outcome. Those who published were able to get promoted since it is a requirement for promotion in universities in Uganda. Those female scientists were also able to successfully compete for fellowships, research, and travel grants in public universities. Lastly, they participated in conferences training, seminars, presentations, and workshops which had been organized by their research networks which equipped them with critical skills that are needed for them to progress in their careers in their universities in Uganda.

Recommendations

To uplift female scientists in research networks in STEM fields in public universities in Uganda, this study recommends that female scientists in the research networks and senior colleagues to act as ambassadors and mentors to those young female scientists in STEM fields. This is because the young scientists may not even be aware of the existence of some of these networks and why they should be part of these networks. But with the presence of mentors, the young scientists may be inspired by the achievements of the research networks that may be shared by the mentors during their mentorship sessions. This may attract more young scientists to join research networks in STEM fields with hope that research networks may help them achieve their academic aspirations including promotions which may result into increased research outputs in universities in Uganda.

Areas for Further Research

As this study was conducted in public universities, it would be valuable to extend the scope to generate further empirical insights through a comparative analysis by including private universities. It would also be important to conduct a qualitative comparative study on experiences of female and male scientists in research networks in STEM fields in Uganda.

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