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Experiences of African women in STEM careers: A systematic literature review.

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Research Paper

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ABSTRACT

The discourse on women's underrepresentation in science, technology, engineering, and mathematics (STEM) mainly centres on the global north, leaving a gap in understanding the perspectives of African women in STEM. To address this, a systematic literature review was conducted to explore African women's experiences in STEM careers and education. After applying inclusion and criteria, 18 published articles were analysed. 8 key issues emerge: work environment, education system, work-life balance, gender-based stereotypes, racial bias, sexual harassment, inadequate support/mentorship, and self-imposed limits. These themes intertwine, with some aspects influencing others. Grasping the complexities and interactions of these factors provides insights into challenges along the 'demand side' of the leaky pipeline. By addressing these challenges stakeholders can develop more targeted interventions to create a more inclusive environment and sustain the participation of African women in STEM fields. This research contributes to ongoing efforts to promote gender equality in STEM disciplines in Africa.

Keywords: Gender gap, STEM, African women in STEM.

INTRODUCTION

Studies found that fewer women study STEM disciplines in Africa (AAS, 2020) while other studies conclude that women who do study STEM fields are less likely to enter STEM careers and exist these careers earlier than their male counterparts (Hammond et al., 2020). Africa reflects relatively low figures of women in STEM as, between 2015-2018, about 13% of women STEM graduates were from South Africa, roughly 12% in Congo D.R. and Kenya, 13% in Rwanda, 6% in Mozambique,19.8% in Ghana and 20.6% in Burkina Faso. While Algeria shows better figures at 58.2% (World Bank, 2020). In research, globally, women account for only 29% of scientific researchers while in Sub-Saharan Africa, women employed in research and development (R&D) were about 31.3%(AAS, 2020). Attempts on the African continent have been made to increase the participation of women in STEM. A training initiative, the Big Data Africa School, (run from 2017 to 2019) was used to introduce students to data science and other aspects such as artificial intelligence (AI) and machine learning (ML) (SARAO, 2021). However female participation was low ranging from 6% to 10% (SARAO, 2021).

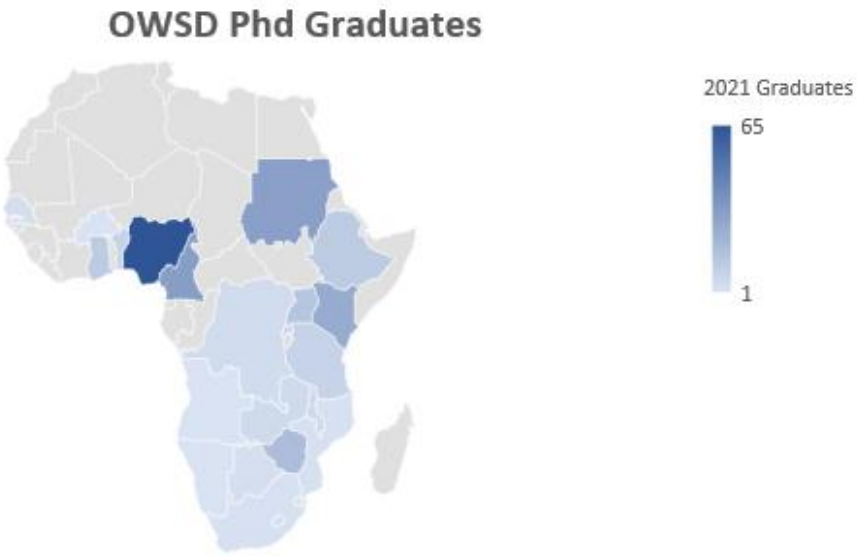
Having an understanding of the experiences of African women in STEM education and careers may provide deeper insights into why the gender gap in STEM fields persists at particular transition points: higher education (HE) and industry. This paper aims to examine the lived experiences of African women in STEM careers through a systematic literature review. While the definition of a career varies, most literature refer to it as the occupation(s)-industry pair in a person's working life (Pavan, 2011; Peter, 2013; Deming & Noray, 2018). For this study, a career considers higher education as part of a person's career. The research question for this paper is: *What are the challenges African women in STEM experience in their career paths?* Okoli (2015) states a systematic literature review is used to summarise existing literature, highlight gaps in the existing literature and propose avenues for future research. The aim was achieved by analysing past research studies on African women in STEM and highlighting persistent challenges. The paper will start with a discussion of the 'leaky pipeline', thereafter the methodology of conducting the systematic literature review is presented. This will be followed by a discussion of the results and limitations.

THE GENDER GAP IN STEM

STEM disciplines have been viewed to be a male-dominated and masculine area of work and study(Nel & Meyer, 2016) consequently these fields are not accommodating to women. In some cultures, women and girls are not expected to be associated with STEM fields due to the gendered stereotypical view of the disciplines and are not encouraged to take STEM subjects in school (Ekine, 2013). Some girls may persist and participate in STEM areas of study or employment. However, over various transitions in their life, there seems to be a 'drop' of girls in STEM fields. This phenomenon is known as the 'leaky pipeline'(Soe & Yakura, 2008; Vitores & Gil-Juárez, 2016). These transitions are girls' STEM journeys from education to industry or academia(Cannady et al., 2014). However, as much as a pipeline is linear in shape, the metaphor has been criticised to be too normative concerning stages in life(Castaño Collado &Webster, 2011; Metcalf, 2010) and how the focus of the pipeline is on the 'supply-side' of women's participation in STEM(Bennett, 2011; Webster, 2011). Having an understanding of the 'demand side' of STEM disciplines and the structural, cultural, social and institutional environments, may provide deeper insights into why the pipeline continues to 'leak' at crucial transition points. While the 'leaky pipeline' reflects the low participation of women in STEM, particularly in academia and research. In 2021, the Organisation for Women in Science in the developing world(OWSD) recorded an encouraging number of PhD graduates from various disciplines. These include structural, cell and molecular biology (19%), biological

systems & organisms accounts (15%), chemical sciences(14%) and medical and health sciences (including neuroscience) at 11%. Smaller numbers of fellows graduated in physics (8%), mathematical sciences (6%), engineering sciences (3%), and astronomy, space and earth sciences (2%)(OWSD, 2021). Figure 1 below shows the number of 2021 OWSD PhD graduates from different African countries (OWSD, 2021).

Figure 1: *OSWD African PhD graduates*



METHOD

This research was conducted as a systematic literature review based on the guidelines by Okoli(2015) and Oosterwyk et al.,(2019). This ensured that the literature was assessed systematically and rigorously. The five major steps conducted based on Oosterwyk et al.,(2019) are described in table 1 below. To find relevant journals related to the research purpose, the two main databases used were Web of Science(WOS) and IEEE Xplore as suggested by Okoli(2015) and Oosterwyk et al.,(2019).

The IS basket of 8 namely-Management Information Systems Quarterly (MISQ), European Journal of Information Systems (EJIS), Information Systems Journal (ISJ), Journal of Management Information Systems (JMIS), Information Systems Journal (ISR), Journal of the Association of Information Systems (JAIS), Journal of Information Technology (JIT) and Journal of Strategic Information Systems (JSIS) recommended by Oosterwyk et al., (2019) were searched. Additionally, the African Journal of Information Systems (AJIS), the Electronic Journal of Information Systems for Developing Countries (EJISDC) and the Pacific Asia Journal of the Association for Information Systems (PAJAIS) suggested by Mwalemba & Mashingaidze(2022) were also searched. As the study looks at interconnected aspects such as gender, technology, development and education, there was a limitation in not having initially recommended journals from sources. The journals selected were based on scope and relevance to the study, however, the journals are not exhaustive.

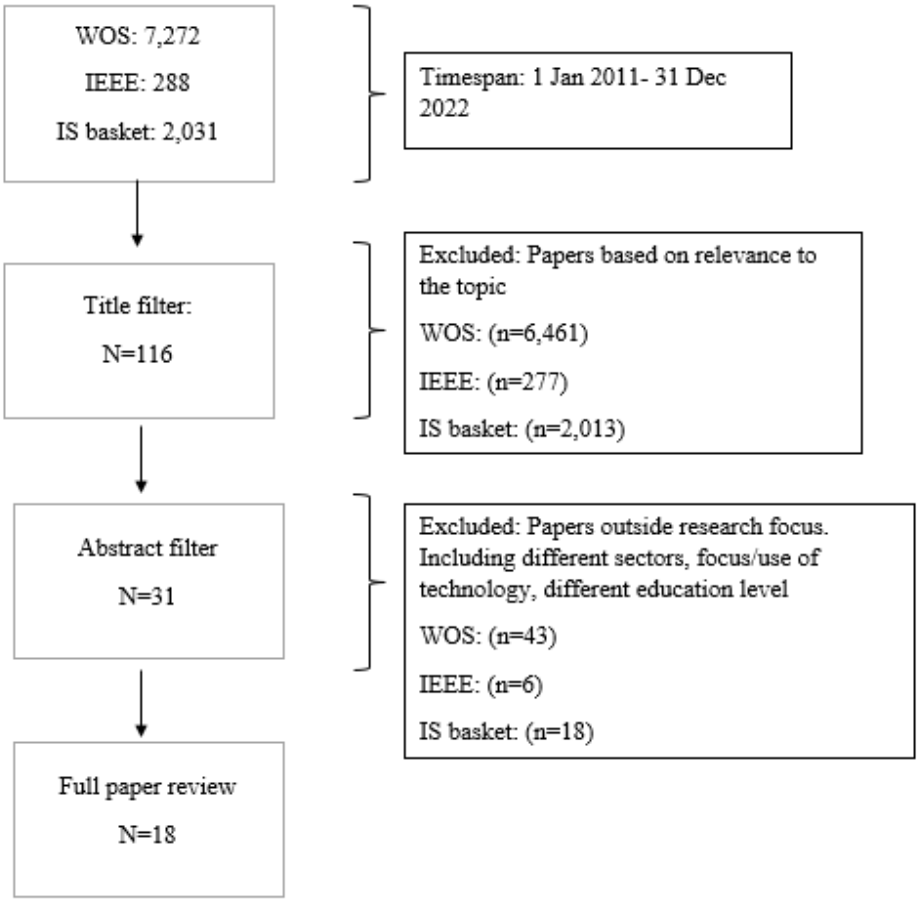
Table 3 (see Appendix A) shows the selected journals and conferences which were manually searched for this literature review. The journals searched went through four rounds in line with the inclusion and exclusion criteria. The inclusion criteria considered articles from Africa with a focus on the STEM sectors.

Articles were excluded if they did not explicitly focus on Africa and if the level of education was outside the focus of the study. Papers were excluded in each round if they did not focus on African women or just mentioned them. Additionally, studies were excluded if the interaction between gender and the STEM disciplines, such as the use of ICT, was not relevant to the study. The first round of the search and selection process of the literature included filtering the papers based on the timespan which was between 1 January 2011 to 31 December 2022, the second round filtered the papers based on the title and its relevance to the research purpose, the third round was based on the content of the abstract and focus of the paper. Finally, the fourth round included reading the full paper. This was done to ensure the study's findings and conclusion were considered after reading the title and abstract. The total numbers shown(see Appendix A) are the sum of the papers after using each of the search terms. Table 4 (see Appendix B) shows the final list of analysed articles and their journal or conference of publication. Figure 1 below shows a diagram of the flow of the search and selection of the articles based on the inclusion and exclusion criteria.

Table 1: *Description of the steps followed in this study based on Okoli (2015) and Oosterwyk et al.,(2019)*

Step	Description	Application
Define the protocol	In this stage, a detailed procedure of the research is defined, including the purpose and scope of the study and the research questions.	The research focused on the participation and retention of African women in technology and by extension the other STEM fields. This was summed by the draft research question, "*What are the challenges African women in STEM experience in their career paths?"*
Search the literature	Identify where to search and determine the search criteria which will be used in extracting data	The search was done in the IS basket of 8 and journals that focused on gender, STEM, education and development. **Search terms**: African women' IN technology workforce', 'African women' IN 'STEM', 'Technology retention' IN Africa', 'African women' IN 'higher education, 'African women' IN technology,' 'challenges/barriers' IN technology', 'challenges/barriers' IN 'higher education' 'Technology participation' AND 'African women.'
Select the papers	Inclusion and exclusion criteria and review papers based on appraisal quality.	**Inclusion**: Peer-reviewed articles from Africa, published in English and focused on the STEM sectors and HE. Explicit focus on African women. Timespan: 1 January 2011- 31 December 2022. **Exclusion:** Peer-reviewed articles from the West. i.e. U.S., U.K, South America, Europe, Australia and New Zealand. Papers that were outside the focus sectors and education level. Additionally, if the interaction of gender and the STEM disciplines was outside the focus.
Analyse and synthesize	In-depth analysis of data to extract	NVivo software was used to conduct an in-depth analysis(coding) and categorization of the data from the 18 selected articles. The articles were analyzed by focusing on the explanation and interpretation of the finding. The articles were coded thematically by looking for similar key issues raised in line with the research aim
Write the review	Write up	Specify the structural elements of the paper to ensure a clear and cohesive outline of the findings and outcome.

Figure 2: *Summary of search and selection process.*



RESULTS

The 18 selected articles were loaded into NVivo and were thematically analysed for initial codes. Duplicate codes were then removed and similar codes were grouped. 36 codes are noted in the final list of codes, thereafter a review was done to establish a link between the codes to generate themes. The final list of codes and categories is shown in the appendix. 8 themes were produced, and these were categorised into 2 abstract areas socio-cultural and institutional. For this paper, socio-cultural issues are seen as factors that are due to a racialized, postcolonial, and patriarchal society(Idahosa & Mkhize, 2021). While institutional factors are about the structures placed to perpetuate gender inequality(Idahosa & Mkhize; 2021). While the various themes analysed from the literature are discussed separately, it is important to note that these factors are interrelated and some may be a result of others or some may be experienced at the same time. Hence these challenges cannot be seen as purely mutually exclusive. Table 2 below shows the 8 themes analysed from the selected articles.

Table 2: *Common challenges of African women in STEM*

Factor	Scholar
Work environment	Garner & Van Staden (2022); Longe et al. (2019); Longe & Ouahada, (2019); Pretorius et al. (2015); Raymond & Canham, (2022); Sekoaila & Adebesin, (2016)
Education system	Garner & Van Staden, (2022); Idahosa & Mkhize (2021); Liccardo & Bradbury, (2017); Mkhize, (2022); Molla & Cuthbert, (2014); Semela et al.(2020)
Work-life balance	Garner & Van Staden, (2022); Longe & Ouahada, (2019); Odoh & Branney (2022); Sekoaila & Adebesin, (2016)
Gender stereotypes	Garner & Van Staden, (2022); Ijagbemi et al. (2017); Liccardo & Bradbury(2017); Longe & Ouahada, (2019); Mkhize, (2022);), Odoh & Branney(2022); Raymond & Canham, (2022); Sekoaila & Adebesin, (2016); Semela et al.(2020)
Racism	Idahosa & Mkhize (2021); Mkhize (2022); Raymond & Canham, (2022)
Sexual harassment	Longe & Ouahada, (2019), Sidelil et al. (2022)
Lack of support/mentorship	Garner & Van Staden, (2022); Idahosa & Mkhize, (2021); Ijagbemi et al. (2017); Sekoalia & Adebesin (2016),
Self-limitations	Longe & Ouahada, (2019)

Institutional

Work environment

The STEM spaces in education, industry and academia have been male-dominated which creates a narrative that the environment is not very welcoming to women. With this masculine culture it can be difficult for women to create social networks and adapt to team dynamics within disciplines such as technology (Pretorius et al., 2015), engineering(Garner & Van Staden 2022), and to have a supportive environment in academia(Raymond & Canham, 2022). It was also seen as a challenge for women to advance to management positions in their ICT careers as most of the positions were largely dominated by men(Sekoaila & Adebesin, 2016; Odoh & Branney, 2022). Concerns such as double standards, being undermined, lower salaries, and leadership challenges were common aspects of employment discrimination women in engineering had experienced(Longe & Ouahada, 2019; Longe et al., 2019). Several papers conclude that a better workplace environment for women may be an intervention for the retention of women in technology and engineering (Ijagbemi et al., 2017; Longe & Ouahada, 2019; Longe et al., 2019).

Education system

Historically, education was only meant for men and women were not entitled to attend schools(Molla & Cuthbert, 2014; Mkhize, 2022; Semela et al., 2022). In Ethiopian HE, there is a perpetuating gendered belief of access to education, in which women in academic roles are being undermined through the use of double standards when they are evaluated

by their male colleagues (Semela et al., 2022). Garner & Staden (2022) describe how women in engineering feel isolated due to the sense of exclusion in the discipline.

In South Africa, the historical legacy of universities affects the positionality and experience of Black women in STEM disciplines (Idahosa & Mkhize, 2021). The racial and gendered belief that the mathematics and science disciplines are only meant for white men preserves a culture that is hostile and isolating for African women (Liccardo & Bradbury 2017; Mkhize 2022). Black women doctoral mathematics students are systematically excluded from being teachers of mathematics. This was due to various reasons such as racism, sexism and classism (Mkhize, 2022). In some cases, the exclusion begins before women enter university. Pressure from school boards to increase the pass rate of mathematics results in rural schools meant schools would make a strategic exclusion of students from taking higher-grade mathematics. Hence the students either do not take mathematics at all or take it a lower grade, which affects African girls who want to take mathematics as a subject(Mkhize, 2022).

Lack of mentorship/support

Some authors recognise that the lack of mentors in engineering workplaces affects the inclusivity in this field as women experience a sense of isolation (Garner & Van Staden, 2022). Other authors describe the lack of role models or mentors as one of the dynamics that created a feeling of loneliness, isolation and depression among black STEM doctoral students (Idahosa & Mkhize, 2021). The lack of mentorship is also seen as a barrier to the career advancement of women (Sekoaila & Adebesin, 2016). Having a mentor while studying a STEM subject in school is seen as a significant influence on a student's choice to pick a STEM career (Ijagbemi et al., 2017). A good support system is discussed as a common key factor in enhancing the retention of women in higher education and workplaces. Whether its among peers and creating bonds to form a sense of belonging (Liccardo & Bradbury, 2017), having mentorship programmes(Longe & Ouahada, 2019), student-industry gatherings and being part of professional bodies (Ijagbemi et al., 2017; Longe & Ouahada, 2019).

Socio-cultural

Work-life balance

It's important to consider another identity of women in STEM spaces--motherhood. The patriarchy is seen as a socio-political mechanism in which power is distributed unequally between men and women to the detriment of women (Ortner, 2022). Johnson (2004) describes patriarchal elements as male-centred and male-dominated which then creates a culture that enforces the way social life ought to be. In the patriarchy, women are primarily seen as caretakers and are mainly in charge of taking care of a household. Idahosa & Mkhize (2021) argue that the role of wife and mother in service to a husband and children are socio-cultural designated roles. In most cases, women are always asked how they balance their work and life, while men are hardly asked the same question as they do not handle the majority if not all the domestic responsibilities in a home.

Work-life balance is described as the degree to which an individual experiences a positive relationship in both work and family roles(Bisschoff et al., 2019). Balancing work and life from the position of being a mother, was seen as the most common challenge among women who discussed their challenges in advancing in their ICT careers in Nigeria and South Africa (Sekoaila & Adebesin, 2016; Odoh & Branney, 2022). Women in engineering also expressed the difficulty of balancing work and family responsibilities (Longe & Ouahada, 2019). Other authors suggest that a woman's need to find a good work-life balance is a possible reason why they do not push for more senior roles, as these roles come with greater responsibility and longer hours at work(Cross & Linehan, 2006). Authors discuss that depending on the context, finding a good work-life could require a multi-faceted approach (Bisschoff et al., 2019). As the ideals in the patriarchy are deeply rooted and complex, the primary parental role and domestic responsibilities will continue to largely fall on the woman or mother but some families may have different dynamics.

Gender stereotypes

It is known that women experience some form of gender discrimination in the workplace either during recruitment or promotions (Longe & Ouahada, 2019; Odoh & Branney, 2022). Sekoaila & Adebesin, (2016) describe the primitive mindset that women are caregivers and men are providers as a career advancement barrier for women in ICT. In the engineering profession, men are usually preferred during recruitment as they appear to be more useful and relevant in everyday tasks(Longe & Ouahada, 2019). Double standards and being overlooked were described as contributing factors to the lack of women in engineering(Garner & Van Staden, 2022). The undermining of women occurs even at the managerial level as women felt that they had to work more to prove they could handle the tasks and schedules in engineering(Ijagbemi et al., 2017). In higher education and academia, gender-based discrimination is seen as a challenge faced by African women in STEM disciplines(Mhkize, 2022; Raymond & Canham, 2022). Black doctoral STEM students in South Africa noted it as one of the reasons why they would not consider an academic career(Idahosa & Mkhize, 2021). Semela et al., (2020) described the overwhelming domestic responsibilities placed on Ethiopian women as an important factor for their absence in higher education. The gendered division of labour affected not only affected their time but resources which could be used towards academic work. An institutional survey done in Nigeria found that female engineering students were mostly affected by gender discrimination in leadership positions, followed by the workplace and then the classroom (Longe et al., 2019). Gender discrimination in STEM fields stems from the stereotypical and patriarchal perspective that women do not belong in STEM disciplines. The gendering of STEM careers is ingrained in girls and boys from an early age and men continue to overtly or subtly, keep women away from STEM fields.

Racism

Depending on the African country, racism plays a large part in the mistreatment of Black women in STEM disciplines. During the apartheid regime in South Africa, universities were segregated in which the majority of institutions were strictly for white English-speaking South Africans (Wolpe, 1995; Breetzke & Hedding, 2018). One of the ideologies

of apartheid was white people would be trained for professional roles and leadership while the standard of black universities would steer black individuals towards roles such as social workers, clerks and nurses(Dubow, 2014).

As a result of this, inequality rose in higher education and some academics believe they still experience race-related exclusionary practices. In some cases, black academics felt that they were not promoted because of their race, despite their competence (Raymond & Canham, 2022). Other authors describe that black women STEM doctoral students would be looked down on and experience micro and macro aggressions which are linked to the historical legacies of higher education institutions in South Africa (Idahosa & Mkhize, 2021; Mkhize, 2022). As much as racism is a factor that affects the participation and retention of black academics in STEM, women's refusal of institutional racism is seen as a counter to this experience. This is done through creating their own supportive spaces, seeking mentorship, and building resilience and strategic solidarities(Jaga et al., 2018; Idahosa & Mkhize, 2021). Raymond & Canham (2022) describe this as pain and pleasure co-existing in the same space.

Sexual harassment

Sexual harassment is the most prevalent problematic issue women in STEM face(NASEM,2018). As an endemic across Ethiopian universities, sexual harassment affects the psychological, emotional and physical well-being of women(Sidelil et al., 2022). Some authors argue that sexual harassment occurs in engineering workplaces mostly due to men and women working in confined spaces for long periods and the spaces being primarily occupied by men(Longe & Ouahada, 2019). Other authors and feminist theories argue that the foundation of sexual harassment has nothing to do with sexual attraction or arousal-it is the continuous problematic reinforcement of patriarchal power and domination (Kloß, 2017). Hence, sexual harassment is understood by scholars to be a structural and in some cases an institutional problem(Sidelil et al., 2022). A study conducted at science and technology universities in Ethiopia found that the occurrence of sexual harassment was seen as a perpetual institutional failure. These universities failed to proactively prevent and efficiently respond to sexual harassment when it occurs (Sidelil et al., 2022). Other authors argue that due to the fear of losing one’s professional stance, the reprisal from the perpetrator and being stigmatised, most women do not report a sexual harassment matter to relevant authorities(Longe & Ouahada, 2019).

Self-limitations

Self-limitations can be seen as a result of the stereotypical gender perceptions of women in STEM. Self-limitations are described as self-imposed boundaries and constraints due to societal, emotional, psychological, physical and mental influences that lead to low self-esteem and lack of trust (Longe & Ouahada, 2019). Traditionally, STEM subjects in schools have been portrayed as masculine fields, while subjects such as home economics and literature have been described as more feminine(Egun &Tibi, 2010). This results in girls believing that they are not capable of understanding or taking the subjects(Longe & Ouahada, 2019), this, in turn, creates a negative perception that the field is not meant for them(Siwale & Mwalemba). The belief of not belonging in STEM areas starts quite early in a girl's education and it continues well into an individual's career. This may be a constraint on the self-confidence and sense of belonging of women in STEM disciplines.

Strategies

Strategies cited in the literature to address the low retention rate of African women in STEM education and industry are shown in Table 2 below. These mechanisms are not exhaustive and further research is needed to critically address the issues raised, to create sustainable and effective strategies or practices. Additionally, the approach of these interventions may vary between individuals, the professional level, organisations, institutions and families.

Table 2: *Strategies*

Challenge	Strategy	Scholar
Work environment	Support network, equalize senior managers, transparent opportunities, fair maternity leave, policies, flexible work arrangements, and address work culture.	Bisschoff et al., (2019); Garner & Van Staden, (2022); Jaga et al., (2018); Nel & Meyer. (2016); Ijagbemi et al., (2017); Longe et al., (2019); Odoh & Branney, (2022); Sekoaila & Adebesin, (2016)
Education systems	Student network centres, career counselling, addressing historical legacies, early exposure to STEM subjects, curriculum change, policies, and scholarships.	Idahosa & Mkhize, (2021); Ijagbemi et al., (2017); Liccardo & Bradbury, (2017); Longe & Ouahada, (2019), Longe et al., (2019); Nel & Meyer, (2016).
Work-life balance	Challenging gender-based roles, open communication in families, support, work boundaries, flexible work arrangements, and on-site childcare facilities.	Bisschoff et al., (2019);Ijagbemi et al., (2017); Jaga et al., (2018)
Gender stereotypes and self-limitations	Inclusive promotion of STEM subjects early, foster a culture of inclusivity in work, HE and society. Parental encouragement.	Garner & Van Staden, (2022); Ijagbemi et al., (2017); Jaga et al., (2018); Longe et al., (2019); Longe & Ouahada, (2019); Nel & Meyer, (2016); Odoh & Branney, (2022).
Lack of mentorship/support	Increasing women in leadership, mentorship programmes, student-industry gatherings, and student network centres.	Garner & Van Staden, (2022); Ijagbemi et al., (2017); Longe & Ouahada, (2019);
Racism and sexual harassment	Programme to foster critical reflexive consciousness on assumptions and stereotypes, mentorship, support networks, revisiting institutional cultures, women leadership, deconstructing patriarchal and hierarchal structures to enhance accountability and transparency, increase awareness of sexual harassment, and functional grievance procedures.	Jaga et al., (2018); Longe & Ouahada, (2019); Raymond & Canham, (2022); Sidelil et al., (2022).

Note. Systemic factors such as racism and sexual harassment are perpetually condoned in institutions and society and hence are quite complex to be completely solved. The mechanisms outlined are skeleton measures and require a thorough implementation.

DISCUSSION, CONCLUSION AND LIMITATIONS

The gender gap in STEM fields continues to persist despite attempts to address this issue. There is a need to focus on why the leaky pipeline continues to 'leak' at particular transition points such as higher education and industry. This will provide deeper insights into structural, institutional, personal, and socio-cultural factors, that may explain the drop of women in STEM, particularly on the African continent. To

understand the persistent gender gap during these transitions, this study conducted a systematic literature review to explore the experiences of African women in STEM careers and education. After applying an inclusion and exclusion criteria, 18 articles focusing on gender, stem and education were thematically coded and analysed.

The analysis revealed 8 common themes present in the selected articles, which were grouped into two broad categories: socio-cultural and institutional. These themes encompass various aspects such as the work environment, education system, work-life balance, gender stereotypes, racism, sexual harassment, lack of support/mentorship, and self-limitations. Although the individual themes were explored independently, they are inherently interconnected, and some themes may stem from others. For instance, the work and education environment pertains to the specific context in which women engage in their STEM disciplines, while the concept of work-life balance delves into the challenge of effectively juggling professional responsibilities with traditional societal roles like being a wife and mother.

Gender-based stereotypes shed light on the conventional perceptions associated with STEM fields and their impact on an individual's sense of belonging within the discipline. On a systemic level, racism and sexual harassment are influenced by historical legacies, perpetuated by the reinforcement of male dominance and power dynamics in STEM domains. The notion of lacking support or mentorship pertains to the feelings of isolation and solitude experienced by women due to the existing low retention rates in these fields. Lastly, the idea of self-limitations can be viewed as a consequence of the gendered stereotypes prevalent in society. These interconnected themes collectively shape the landscape for African women in STEM, reflecting the intricate interplay of socio-cultural and institutional factors. Having a support system is seen as the most common form of strategy to counter the experiences. This could be friends, family, colleagues or mentorship.

A few limitations in this paper include the individual researcher searching and selection process as most literature suggests conducting the systematic review as a team to ensure a cohesive and efficient process. Additionally, most literature focused mainly on STEM from the global north perspective, and few articles focused on African women. In turn, a few papers focused on technology concerning gender, most focused on the use of ICT in communities or organisations. As much as the study conducted a thorough search process, the research cannot guarantee an exhaustive account of all relevant journals due to the different aspects of the scope-gender, education, stem and development. Future research can examine how certain practices can be adopted to ensure a sustainable environment for women in the workplace and higher education. Comparing regions in Africa can also be studied to note contextual variations or similarities. Differences in experience between STEM disciplines, if any, can also be investigated. It would also be interesting to consider the perspectives of African women who left a STEM discipline.

APPENDICES

Appendix A: Selected journals and conferences

Table 3: *Selected journals, conferences, and the total number of relevant articles*

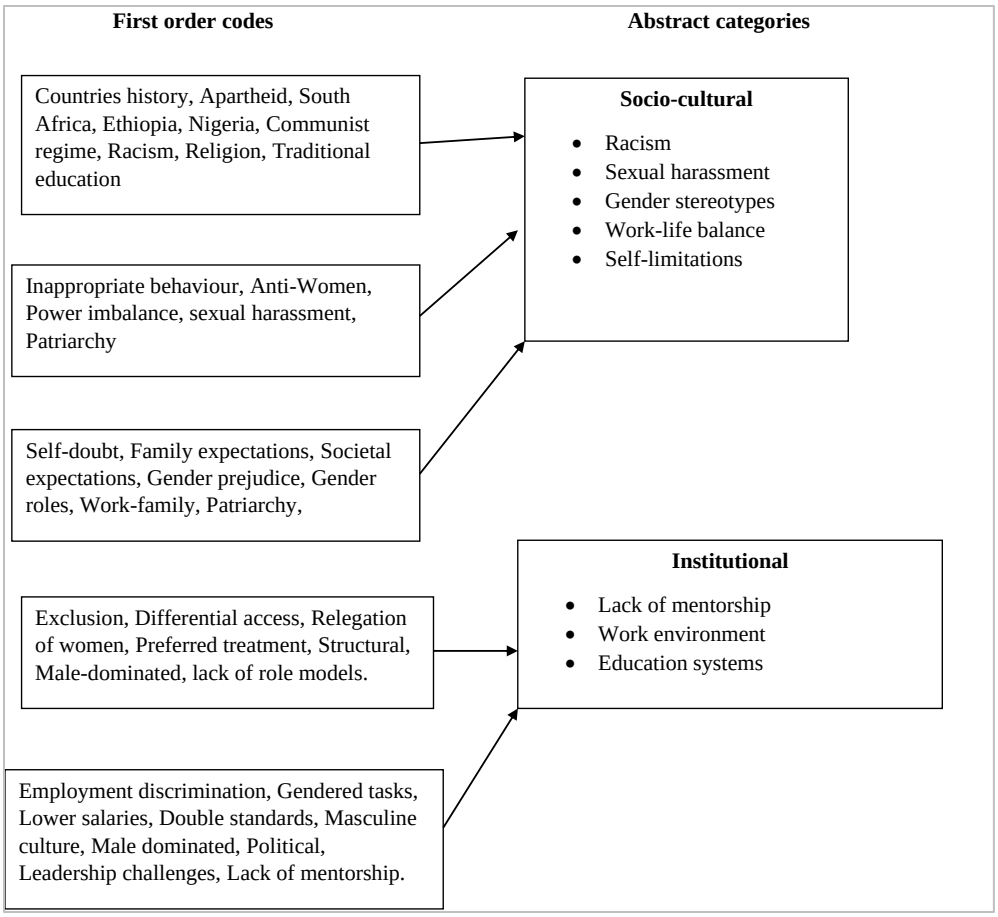
Journal	Round 1(timespan)	Round 2(title)	Round 3 (abstract)	Round 4(full paper)
Gender & Education	615	14	4	4
Gender & Development	415	0	0	0
Gender, Technology & Development	383	2	2	2
Gender, Work & Organisation	712	14	2	0
Community, Work & Family	213	10	4	2
South African Journal of Higher Education.	1690	12	3	1
IS basket	1,418	20	3	0
Electronic Journal of Information Systems for developing countries	613	3	2	1
Journal of gender studies	324	5	3	0
African Education Review	414	1	0	0
African Journal of Science, Technology, Innovation and Development	974	3	2	1
African Journal of Research in Mathematics, Science and Technology Education.	157	4	2	1
Agenda	534	3	2	1
IEEE conferences	228	11	5	5
Total	8,690	102	34	18

Appendix B: Final 18 articles

Table 4: *Final list of analysed papers*

Journal /Conference	Article
Gender & Education	Molla & Cuthbert, (2014), Semela et al.(2020); Raymond & Canham, (2022); Sidelil et al. (2022)
Gender, Technology & Development	Pretorius et al. (2015); Odoh & Branney (2022)
Community, Work & Family	Jaga et al., (2018); Bisschoff et al. (2019)
Transformation in Higher Education	Mkhize(2022)
Electronic Journal of Information Systems for Developing Countries	Siwale & Mwalemba(2022)
African Journal of Research in Mathematics, Science and Technology Education	Liccardo & Bradbury(2017)
African Journal of Science, Technology, Innovation and Development	Ijagbemi et al. (2017)
Agenda	Idahosa & Mkhize, (2021)
IEEE AFRICON	Longe & Ouahada(2019); Longe et al. (2019)
International Conference on Industrial Engineering and Engineering Management (IEEM)	Nel & Meyer (2016)
Conference of the European Association for Education in Electrical and Information Engineering (EAEEIE)	Garner & Van Staden (2022)
IST-Africa Week Conference	Sekoaila & Adebesin(2016)

Figure 3: *List of codes and abstract categories*



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