CHAPTER 9

Pedagogical Efforts to Address Gender Disparities in STEM Higher Education in Sub-Saharan Africa: A Scoping Review

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Introduction

> "We African girls and women deserve to study science. Science needs us."
> Armanda Kouassi (2016)

Education in Science, Technology, Engineering and Mathematics (STEM) is seen by many countries as a national priority for economic development (Melak & Singh, 2021). Globally, fewer women than men enrol for STEM degrees, and retention and graduation rates are frequently unequally distributed between men and women. Gender inclusivity in STEM is influenced by gender stereotypes, mentoring and pedagogy (UNESCO, 2024a). These play out differently across cultural and political contexts, meaning that the reasons women may feel inhibited from participating in STEM in Southeast Asia would be different from those in North America, for example. This chapter contributes to the corpus of literature on women in STEM by focusing on sub-Saharan Africa (SSA), as limited research has been conducted to determine factors affecting women's STEM participation within this context. We present a scoping review identifying the research which has been conducted in SSA investigating the interactions between gender, pedagogy and STEM within undergraduate higher education. The research question addressed in this chapter is as follows:

> What is the current state of evidence on the intersection of gender with pedagogy and policies in undergraduate STEM-focused disciplines in SSA higher education institutions?

To provide an in-depth investigation into this question, we overview the following areas as they pertain to this corpus of literature: the contextual landscapes around STEM education, the factors related to female success in STEM, interventions affecting female success in STEM, and policy and practice recommendations provided within these studies. This scoping review provides an overview of the current evidence on gender-responsive pedagogies in SSA, highlights opportunities for policy intervention, and informs policy and research recommendations. The goal of our review is to inform a collaborative research agenda regarding how pedagogical practices can address issues of gendered exclusion in STEM disciplines in SSA's higher education institutions (HEIs).

The underrepresentation of women in STEM stifles countries' capacities to solve their complex development problems: "women's experiences – along with men's experiences – should inform and guide the direction of engineering and technical innovation" (Hill et al., 2010, p. 92). Globally, an average of 35% of STEM graduates are women, a finding which is consistent across most world regions (UNESCO, 2024b). In addition, fewer women than men progress from one educational level to the next, that is, from bachelor's to master's to doctoral levels (Almukhambetova et al., 2023), and women complete advanced degrees at a lower rate than men (Fisher et al., 2020).

Although SSA has the same average female participation rate in STEM as the global average, there is variation between countries (UNESCO, 2024b). For example, in Tanzania more women than men graduate with STEM degrees, while in Niger, Chad and Ghana fewer than 20% of STEM graduates are female (UNESCO, 2024b). This disparity between countries underlines the importance of considering how women's participation in STEM studies interacts with cultural and political contexts.

To increase the participation and retention of women in STEM in higher education, it is first necessary to acknowledge that women face significant challenges while pursuing their studies. Women may be discouraged from participating in higher education by family and community expectations around marriage, child-rearing and domestic responsibilities (Tukahabwa, 2018). Female students in STEM HEIs in SSA are alienated by the teaching approaches used and by the attitudes of both their educators and their male classmates, who routinely underestimate their achievements and abilities (Chapin et al., 2020).

Socio-cultural perceptions that have traditionally constructed STEM as a masculine domain (Namatende-Sakwa, 2018; Onyeocha et al., 2023), and that males are 'better' at mathematics and science, inhibits the participation of women in these fields. Kouassi (2016), speaking from her experience, notes that girls in primary and secondary education with interest in STEM have been labelled as "half-men", and discouraged from taking scientific track subjects. Should they continue and attend university, women face isolation, hostility and a lack of female role models. Female engineering students report being intimidated by some male lecturers which leads them to participate only in 'soft' tasks during practical lessons, thus impeding their exploratory abilities (Omari & Kouevi, 2023). In group projects, female students are often relegated to administrative roles (Simpson & Bester, 2015).

The gender divide in STEM education is perpetuated by patriarchal education structures as well as by educators' beliefs and pedagogical practices (Chikunda & Chikunda, 2016). This is being addressed by national and regional policies which have instigated efforts to infuse a gendered approach into the teaching and learning process in general, and in STEM in particular. Underpinned by the work done by the Forum of African Women Educationalists (FAWE), the International Network for Advancing Science and Policy (INASP) in collaboration with partners in East Africa has developed a gender-responsive pedagogic framework for HEIs (Chapin et al., 2020). The Association of African Universities (AAU) (2006) similarly produced a toolkit on mainstreaming gender in higher education some years ago. The Partnership for Pedagogical Leadership in Africa (PedaL) is a collaboration between eight African HEIs to embed and catalyse systemic change in teaching and learning in African universities (PASGAR, 2023).

It is important to understand how, and to what extent, gender-inclusive policies and frameworks are enacted within the individual institutions and classrooms in the SSA higher education space. This chapter contributes to addressing this question via a scoping review of the literature. The purpose of the scoping review is to determine the extent and range of literature on this topic – using the publications as contextualised examples – and to identify gaps for future study. This is particularly necessary given that literature from SSA is limited and difficult to isolate within the large body of global literature on gender-inclusive pedagogy.

Methods

A scoping review is used here for two reasons: first, to examine the extent, range and nature of research activity around pedagogies of inclusion in gender; and second, to identify research gaps in the existing literature (Arksey & O'Malley, 2005). Arksey and O'Malley's (2005, pp. 21–22) methodological framework outlines five required stages for conducting a scoping review:

- Stage 1: Specify the research question
- Stage 2: Identify relevant literature
- Stage 3: Select studies
- Stage 4: Extract, map and chart the data
- Stage 5: Collate, summarise and report the results

In our approach, we have made pragmatic decisions to be sufficiently comprehensive while having the required work remain feasible. We have worked iteratively and interactively to refine the research question, the search strategy, the data extraction framework, and to extract and summarise the data. This is in line with Levac et al.'s (2010) recommendations.

Stage 1 – Specify the research question

The research question which guides the search strategy asks: "What is the current state of evidence on the intersection of gender, diversity, inclusion and pedagogy in STEM-focused disciplines in SSA HEIs?"

This research question is broader than the research question answered by the chapter, since in ongoing work we are also examining broader aspects of diversity and inclusion.

Stage 2 – Identify relevant studies

In Stage 2 of the scoping review framework, we identify relevant literature to answer the research question. We developed a search strategy based on the five key concepts in the research question, namely:

- SSA;
- Undergraduate higher education;
- STEM;
- Gender, diversity and inclusion; and
- Pedagogy.

Each concept was expanded using related terms, resulting in the search strings shown in Table 1. There is no standard definition for which fields should be considered as STEM disciplines. Since female participation rates in health sciences are considerably higher than in the natural sciences, engineering and technology (European Commission: Directorate-General for Research and Innovation, 2019), we have excluded health sciences from our definition of STEM. We have included agriculture, which is prominent in SSA research (see Chapter 4 for a detailed case study on agriculture as a STEM field).

Through initial searches, and in consultation with librarians at Curtin University and the University of Johannesburg, we developed a list of possible databases. We selected six databases: Web of Science, Scopus, ProQuest Central, ProQuest Dissertations and Thesis, ERIC and EBSCOHost. We searched using the search string shown in Table 1, including the title, abstract and summary fields as search fields. This resulted in 13 995 results.

Table 1: Search terms

Concept	**Search terms (in title or abstract)**
Sub-Saharan Africa	Africa* OR Algeria OR Angola OR Benin OR Botswana OR "Burkina Faso" OR Burundi OR "Cabo Verde" OR Cameroon OR Chad OR Comoros OR Congo OR "Côte d'Ivoire" OR "Equatorial Guinea" OR Eritrea OR Eswatini OR Ethiopia OR Gabon OR Gambia OR Ghana OR Guinea OR Kenya OR Lesotho OR Liberia OR Madagascar OR Malawi OR Mali OR Mauritania OR Mauritius OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR "Sao Tome and Principe" OR Senegal OR Seychelles OR "Sierra Leone" OR Somalia OR "South Africa" OR "South Sudan" OR Sudan OR Swaziland OR Togo OR Uganda OR Tanzania OR Zambia OR Zimbabwe
Higher education	"higher education" OR universit* OR college* OR "tertiary education" OR "tertiary institute*" OR "higher learning" OR TVET OR "technical and vocational education and training"
STEM	STEM OR science* OR technolog* OR engineering OR maths OR mathematics OR astronomy OR astrophysics OR chemistry OR physics OR geoscience* OR biolog* OR biochem* OR biophysics OR microbiolog* OR zoology OR physiology OR agriculture OR computer OR programming
Gender and inclusion	gender* OR female OR diversity OR inclusi* OR women OR blind OR "vision impaired" OR disab* OR accessibility
Pedagogy	pedagog* OR teaching OR "teaching strategies" OR "student experiences" OR "social impact" OR factors OR support OR curricul* OR success OR intervention* OR learning OR "foundation programme*" OR "innovative teaching"

Note. Search terms included in the able are Boolean search terms. * represents that the search term could have any possible ending, for example "Africa*" would be inclusive of terms "Africa" and "African" and "universit*" would include "university" and "universities".

Stage 3 – Select studies

In the study selection process, items are screened to select sources of evidence to answer the research question. The 13 995 items found from the databases were first extracted to Zotero, where duplicates were removed. The remaining items were extracted to a spreadsheet for screening against the inclusion criteria, which are described in Table 2.

Table 2: Inclusion criteria to determine relevant papers

Inclusion criteria	Details
The study is located in SSA.	SSA is the focus of the review.
The study investigates undergraduate higher education.	This review considers only undergraduate tertiary education, including both university and vocational education. Primary and secondary education, postgraduate studies and work after graduation are excluded.
The study focuses on STEM courses.	Multiple definitions exist for STEM. As discussed above, we have excluded health sciences and have included agriculture.
The study explicitly investigates gender, diversity or inclusion.	Gender is the primary focus of the review. Other dimensions of diversity are also included as they may add insight.
The study reports on pedagogical interventions or success factors.	Pedagogical interventions are the primary focus of the review. Studies which investigate success factors are included to add context.
The study is written in English.	Due to limited resources for translation, we excluded papers not written in English.
The full study is available.	A small number of studies were excluded because we were not able to access the full text.

Due to the large number of items which were found, the screening was done in stages. The items were first screened based on title only and then screened based on the abstract. The full texts for the remaining items were downloaded for full text review. The process was consultative and done iteratively as required by the researchers. The results of the screening process are summarised in Table 3.

The inclusion/exclusion criteria ensure that only search results that pertain to undergraduate STEM higher education in SSA are included. The included results were categorised to identify literature that pertains to *pedagogy* (defined here as the methods and practices of teaching and learning as enacted through classroom, curricular and assessment practices) as opposed to enrolment, graduation rates and other *factors* that speak to female students' experiences in higher education, but do not specifically relate to pedagogy. The results were also classified to identify those which focused on *gender* as opposed to those which investigated other dimensions of *inclusion*.

The primary category of included articles was SSA studies in STEM higher education that integrated "*Pedagogy and gender*". These studies report on or discuss pedagogical interventions in STEM in higher education in SSA through the lens of gender. This includes interventions aimed specifically at women, or those in which gender was a key variable studied. These studies are at the core of the scoping review analysis.

The second category of included articles was SSA studies in STEM higher education that integrate "*Factors and gender*". These studies investigate STEM in higher education in SSA, but do not specifically involve pedagogy; instead, they report on empirical work that aims to understand the 'factors' that impact women's success, persistence, or enrolment in STEM programmes. These studies are included in the scoping review, but only insofar as they offer implications for STEM pedagogy in higher education.

Table 3: Items included at each stage of the search

Stage	Details	Exclusion
Initial search 13 995 items	**Sources:** EBSCOHOST (4 127), ERIC (605), Proquest Central (3 828), Proquest Dissertations and Thesis (768), Scopus (2 305), Web of Science (2 362)	Removed duplicates (5 602)
Title review 8 393 items		Not SSA, Not STEM, Not higher education, Not relevant, Not in English
Abstract review 1 640 items		Not SSA, Not STEM, Not higher education, Postgraduate / Workplace, No factors or pedagogy, No gender or inclusion, Infrastructure, Too broad, Not relevant, No abstract, Duplicate
Full text review 149 items	**Key themes:** Pedagogy and gender (29), Factors and gender (119), Gender (1)	No specific focus on gender, No specific focus on STEM, Not in higher education, Not in English, Not available
Final inclusions 25 items	**Key themes:** Pedagogy and gender (11), Factors and gender (14)	

Stage 4 – Extract the data

We began data extraction by reading 10 primary articles from those that had been selected for full text review. Based on these initial articles, three of the researchers (EM, BR and HI) developed a preliminary data extraction framework. Two of the researchers (EM and BR) then piloted the data extraction framework independently using a further subset of papers. This strategy allowed for discussion of the emerging findings and iterative editing of the framework. The finalised data extraction framework included:

- Author(s);
- Year of publication;
- Title of publication;
- Type of publication as well as publisher;
- Inclusion category;
- Study location (country the study is conducted in);
- Contextual landscape around STEM;
- Type of STEM;
- Topic;
- Study aim and/or research questions;
- Methodology;
- Data collection;
- Study populations and participants;
- Factors investigated;
- Intervention type;
- Outcome of intervention;
- Results and key findings; and
- Practice/policy recommendations.

The extracted data will be discussed in the Results section of this chapter.

Stage 5 – Collating, summarising and reporting the results

The researchers worked collaboratively to extract information from the papers into the data framework, discussing uncertainties and resolving conflicts. After full text screening, 25 papers were included for analysis, of which 11 were in the category of "*pedagogy and gender*" and 14 were in the category of "*factors and gender*". The results from these papers are reported in detail in the next section. Note that, in contrast to a systematic review, according to Arksey and O'Malley (2005, p. 27), in a scoping review

> there is no attempt made to present a view regarding the 'weight' of evidence in relation to particular interventions or policies. This is because the scoping study does not seek to assess quality of evidence and consequently cannot determine whether particular studies provide robust or generalisable findings.

Results

Overview of the publications

The 25 papers which form the focus of this study include 18 journal articles, 3 conference papers, 3 dissertations and 1 book chapter. The journal articles were published in STEM education journals (n=5), education and higher education journals (n=7) and interdisciplinary and social sciences journals (n=6). The papers use a range of methodologies, including qualitative (n=12), quantitative (n=5) and mixed methodologies (n=8).

The search timeline was not restricted. The studies analysed in this chapter were published between 2001 and 2023, with the majority (n=18) published in the last 10 years, and only a few (n=7) published in the prior 15 years (see Figure 1). The papers represent studies conducted in 12 SSA countries, with the largest number of sources from Ethiopia (n=7); the distribution by country is illustrated in Figure 2.

The studies that were included focused on five main areas (note that some studies fall into two areas).

1. Gender disparity in STEM higher education (n=9), which includes participation of female students, gender gap, underrepresentation of women, enrolment and graduation issues, as well as access and retention.
2. Student success or performance in STEM higher education (n=8) including female students' persistence, academic performance and/or achievement, conceptual understanding, engagement and confidence.
3. Gender-sensitive/responsive pedagogy (n=2).
4. Female students' attitudes towards learning in STEM (n=4) including attitudes towards mathematics, computer sciences and programming, as well as reluctance to use mobile phones for learning.
5. Gender biases and discrimination (n=3) including sexual and gender-based violence and other challenges in learning STEM-based studies.

These areas are broadly representative of studies of gender in STEM higher education. The volume of literature in each category is limited compared to what has been produced globally, hence the importance of identifying literature from SSA contexts.

In the remainder of this section, we summarise the results of the included literature. Since we have not assessed the quality of the literature, we do not make general claims but limit ourselves to identifying themes and reporting on

Figure 1: Publication distribution by year

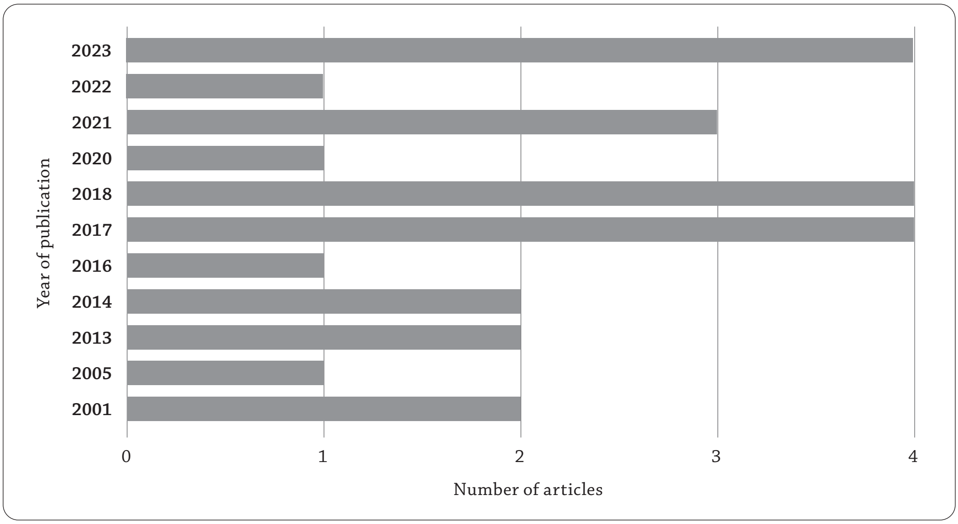
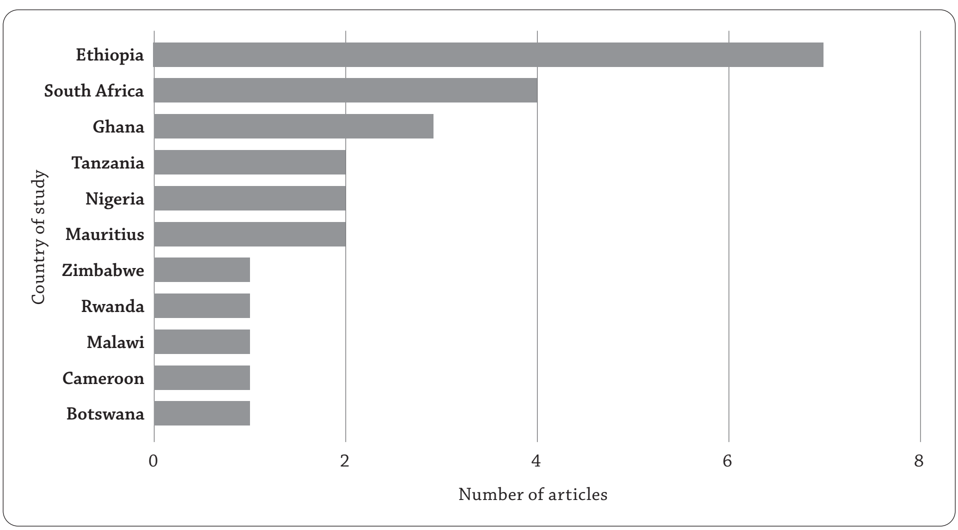


Figure 2: Publication distribution by country



study results. First, we describe details of the national contexts in which STEM education takes place. Next, we discuss studies which have investigated the factors that influence female success in STEM higher education. Subsequently, we focus on pedagogical interventions which aim to improve success. Finally, we report on policy and practice recommendations arising from the surveyed literature and highlight policy–practice gaps.

Contextual landscape around STEM education

It is crucial to consider the contextual landscape around gender and higher education in the included literature as sub-Saharan Africa is a diverse region and contextual factors, such as higher education frameworks and policies, and the positioning of women in society have a marked effect on the participation of women in STEM. Below, we summarise some of the contextual factors raised in the included literature.

Most of the studies agree that despite there being many efforts in improving the gender disparity, participation of female students in STEM disciplines in higher education remains low (Baguant, 2021; Kahamba et al., 2017; Kassie, 2018; Sanga et al., 2013) although improving in some contexts such as Ghana (Appiah-Castel et al., 2020).

Several studies discuss a national focus on female enrolment in STEM education through a range of governmental policies. Ethiopia has invested significantly in higher education, which is supported by 43% of the total education budget (Hailu, 2018) with the aim of increasing STEM graduates. The government requires that 70% of overall university enrolment is in a science field, with the remaining 30% in the social sciences and business economics (Melak & Singh, 2021). Ethiopia also prioritises increasing the number of women studying STEM in higher education (Wuhib, 2017). This is achieved in public institutions by government placement of students in institutions and programmes of study, rather than students applying directly for their choice (Wuhib, 2017). Mbano and Nolan (2017) report that at the time of their study, STEM was the area of focus in Malawi and there was a policy to increase enrolment of females in non-traditional areas by the Malawian government. In Rwanda, a strategic plan pledged to ensure gender equality at all levels of education (Tukahabwa, 2018). In Zimbabwe, the government established a National Gender Policy with a section on the education and training sector. According to Chikunda (2014, p. 9), the policy section includes a number of strategic goals, including to "incorporate gender issues in all curricula at all levels of education" to "eliminate … discrimination against boys and girls in education and skills training"; to "encourage girls to take on science, mathematics and technology at all levels of education"; and to "introduce gender awareness programmes to pre- and post-training teacher courses".

There are other contextual issues affecting the participation and performance of female students in STEM, including socio-cultural circumstances. For example, Rwanda's socio-political economic landscape bears the scars of the 1994 genocide. The post-genocide government has adopted a policy to recruit women in positions of power, which has played a role in motivating young women (Tukahabwa, 2018). In Ethiopia, Sadati (2018, p. 364) reports that "SGBV [sexual and gender-based violence] is one of the major problems faced by female students in post-secondary institutions". In Sierra Leone, the 2014 Ebola crisis, following on from the civil war which ended in 2002, reversed economic gains. This has increased women's economic vulnerability, reduced their access to education and exposed them to "multiple forms of sexual and gender-based violence" (Wignall et al., 2023, p. 130).

Factors which impact female success in STEM

Factors which the papers in the study identify as affecting women's success in STEM at university can be grouped into (1) factors which affect enrolment in STEM courses; (2) factors which affect persistence and achievement in higher education; and (3) women's experiences of studying STEM.

The enrolment of women in STEM higher education is impacted by their experience of STEM in secondary education. Baguant (2021) emphasises that the image of STEM contributes to women's choices, as does access to information on STEM fields. Baryeh et al. (2001) highlight the impact of counselling in secondary schools. Women's enrolment in STEM is also affected by encouragement from parents and teachers (Tandrayen-Ragoobur & Gokulsing, 2022). In many countries, there are strong socio-cultural influences that affect women's choice of STEM subjects (Kassie, 2018; Melak & Singh, 2021), including "community expectations and domestic responsibilities" and "the complex relationship between marriage, schooling and career development" (Tukahabwa, 2018, p. 168). E-learning can potentially provide a culturally appropriate alternative to in-person education for female students (Sanga et al., 2013) but is hampered by low access to computing and internet resources. National or institutional admissions policies which give preference to female students positively impact enrolment (Appiah-Castel et al., 2020).

The achievement or success of female students within the higher education environment is affected by internal as well as external factors. Internal factors include agency, attitudes, persistence, coping strategies, learning habits and resilience (Hailu, 2018; Kebede, 2023; Melak & Singh, 2021). External factors which impact success are female role models, a supportive environment, academic support for students who are struggling, national employment opportunities and gender-responsive practices (Baryeh et al., 2001; Hailu, 2018; Melak & Singh, 2021).

Women's experiences in STEM higher education are negatively impacted by gender inequalities and gender discrimination "manifested in comments, structures, and practices" (Boateng, 2016, p. 24), requiring that "female scientists challenge the socio-economic and cultural constructions of society to pursue careers in science" (Tukahabwa, 2018, p. 132). Kassie reports that "all participants have agreed on unwelcoming sphere of educational institutions" (2018, p. 168), partly due to "[m]ale students' and teachers' perception and scorning behaviour on girls" (2018, p. 168). Sadati records a variety of more serious gender-based problems, including emotional violence and sexual harassment (2018).

However, Boateng (2016) also reports that women's experiences of gender discrimination vary depending on their personal support systems, which may include support from their family, their faith, their community and their employer. This points to the importance of intersectional approaches to confronting the challenges experienced by female students (Sikhosana et al., 2023).

Interventions affecting female success in STEM

Of the analysed studies, 11 studies reported on interventions aiming to improve female student achievement or student performance in general.

Shishigu et al. (2017) used a five-step problem-solving strategy form of problem-based learning (PBL) to improve female students' conceptual understanding in physics. The intervention had a substantial positive effect, and students were motivated to continue using the strategy. Pair programming in an introductory computer science course required students to work in pairs to complete a six-week programming lab assignment. This was observed to improve female students' performance as well as sense of self-efficacy (Mitchley et al., 2014). Alternative assessment methods for mathematics, including group discussions, reflective journals and portfolios were shown to improve female pre-service mathematics teachers' attitudes towards mathematics as well as their conceptual understanding (Eshun & Abledu, 2006). Mbano and Nolan (2017) assessed two two-week bridging course camps run by the University of Malawi for female students as preparation for entering university. The bridging course camps included sessions for study and research skills, personal and self-development skills, tutorials for STEM subjects to enhance concept understanding, guest speakers and field trips. Mbano and Nolan (2017) found that there was a positive impact on academic performance, and a more noticeable improvement in participants' motivation to study and in their study skills. Magunje and Brown (2013) investigated four female students' use of mobile phones as a primary computing device. One student felt increasingly disconnected and isolated, but the other students experienced this as an enabling pathway into using computers.

Several pedagogical interventions were not specifically linked to the success of female students or did not find any significant difference between male and female students. A constructionist approach to teaching programming was compared to a conventional teaching approach with lectures and unguided practical sessions by Campbell et al. (2023). The constructionist teaching approach emphasised student collaboration and exploration, with the students working in groups on different real-life projects. Students in the constructionist group showed greater improvement on a standardised programming test. However, there was no significant difference between male and female students (Campbell et al., 2023). An intervention to train spatial thinking as a core part of the first-year engineering graphics course has shown sustained benefits over 20 years (Potter et al., 2006). In this study, female students, as well as students with no prior exposure to technical drawing, entered university with lower spatial visualisation ability. The intervention demonstrated that spatial thinking is a teachable skill and it is predictive of success in engineering studies; thus, it is a valuable contributor to changing student outcomes (Potter et al., 2006). Peter et al. (2021) report on female engineering students' perceptions of entrepreneurship education as a curricular intervention to encourage startups. The curriculum was found to develop critical thinking and innovation, but not to offer enough practical exposure. The authors recommend that women collaborate with other women to learn most effectively (Peter et al., 2021).

Although the focus of our scoping review was on pedagogical interventions that are related to gender, other interventions emerged that, although non-pedagogical, had the potential to impact female students' academic performance and overall success. Wuhib (2017) found that creating residential communities of undergraduate women in STEM in Ethiopia played an important role in their social and academic integration, which in turn helped them in their academic programmes. Wignall et al. (2023) presented the Upskilling for Future Generations Project (Gen-Up), in partnership with the Salesian Don Bosco professional centres in Cameroon and Sierra Leone, which provide technical and vocational education and training (TVET). Gen-Up explores how TVET provides mentorship towards decent employability for vulnerable young women and can challenge systemic gender discrimination. The research has shown the great potential of TVET for transforming outcomes for women, albeit within communities which remain gendered.

Scholarships and admission strategies have also been effective in helping more women access STEM higher education. In Ghana, Kwame Nkrumah University of Science and Technology (KNUST) embarked on an initiative to deliberately increase the admission of females in STEM programmes by lowering the required aggregate score in 2009, and mentoring girls from secondary schools to choose STEM careers (Appiah-Castel et al., 2020). Additionally, KNUST has partnered with the MasterCard Foundation to provide scholarships for women.

Recommendations from studies for policy and practice

In this subsection, we summarise the policy and practice recommendations for government and HEIs made in the included studies. While some of the recommendations are specifically focused on gender, others aim to enhance success for all students.

To increase female enrolment in STEM, some studies recommend that governments and universities review and reframe access strategies for female students (Hailu, 2018; Mbano & Nolan, 2017). HEIs are recommended to provide pre-entry programmes or bridging courses for entering students (Mbano & Nolan, 2017; Sanga et al., 2013), and the government and the private sector are urged to offer scholarships, financial support and other incentives to women who enrol in STEM programmes (Baguant, 2021; Baryeh et al., 2001).

To promote women's success in STEM in HEIs, the included studies recommended that universities should use teaching and learning strategies that increase engagement, including more active and interactive forms of teaching and learning (Baguant, 2021), such as problem-based learning (Hailu, 2018; Shishigu et al., 2017) and peer learning (Melak & Singh, 2021). It is also recommended that marginalised students be provided additional academic support, including extra lessons in STEM subjects such as maths, physics and programming (Baryeh et al., 2001; Sikhosana et al., 2023). Sanga et al. (2013) propose e-learning as a complement to face-to-face teaching and learning, and recommend that HEIs teach computer courses to students, and that governments develop a plan to improve communications infrastructure and increase bandwidth and connectivity.

Melak and Singh (2021) recommend a holistic strategy to provide female students with psychological, economic and academic support, including creating supportive infrastructure and learning facilities, and protecting students from sexual harassment. In the same vein, Hailu (2018) recommends strengthening existing institutional support structures including increasing the scope of gender offices, reimagining first-year orientation and redesigning on-campus residence halls. Wuhib (2017) makes recommendations to improve the effectiveness of residential communities in supporting women in STEM, in particular, the design of residence halls as Living-Learning Programmes, with attention given to orientation and mentoring of female students. Wuhib (2017) also recommends, in the case of Ethiopia, that individual choice be considered when the government allocates students to study programmes.

Several studies emphasise the importance of interactions across institutional boundaries. Two studies recommend career counselling for girls in secondary schools and women in universities both before and after selecting STEM courses (Baryeh et al., 2001; Mbano & Nolan, 2017). Studies recommend role models and mentors for female STEM students in secondary and tertiary education. For example, Baryeh et al. (2001) believe that successful women engineers should be invited to secondary schools as role models. Baguant (2021) recommends connecting with female role models through collaborative linkages with industry. Sikhosana et al. (2023) advocate for progressive policies that ensure higher representation of Black women academics in positions of authority in STEM fields, to ensure the availability of women mentors.

The included studies recommend that HEIs employ gender-responsive curriculum practices, or gender-responsive pedagogy (GRP). This begins with awareness campaigns and workshops to develop STEM educators' awareness of gender (Kahamba et al., 2017) and of their role in perpetuating cultural norms (Chikunda, 2014). Professional development of lecturers is recommended for teaching staff to learn how to develop and implement gender-sensitive teaching and assessments (Chikunda, 2014; Kahamba et al., 2017).

The papers analysed and reported on in this chapter identify disjuncts between policy and practice regarding inclusive pedagogy in STEM higher education in SSA. For example, Kassie (2018) identifies a policy–practice gap in Ethiopia's implementation of affirmative action, allowing female students to be admitted to university STEM programmes with lower school marks than male students. The study found that women had higher rates of academic dismissals as compared to men, which was attributed in part to a lack of planned academic support for these less well-prepared female students (Kassie, 2018). The policy–practice gap is particularly clear in the two included studies where gender-responsive pedagogy was reviewed. According to Kahamba et al. (2017), lecturers' awareness of gender-responsive pedagogy at their Tanzanian university was high, but their understanding was limited, and they therefore did not fully or consistently implement gender-responsive pedagogy. This was explicitly studied, using activity theory, by Chikunda (2014), who identified that lecturers experience tensions between multiple value systems. Among the causes of these tensions are "gender blindness", "lack of conceptual tools for gender-responsive pedagogies" and "lack of learner-centred pedagogies". Chikunda argues that curriculum transformation requires more than policies but should leverage research in gender and science education to "reflexively engag[e] with intended policy implementers such as teacher educators to enable them to look at themselves; to examine their own practices and change them; and to reflect on and talk about the social world" (Chikunda, 2014, p. 274).

Conclusion

This scoping review summarises the extent of literature on external factors and interventions that influence the enrolment and retention of female higher-education students in STEM fields in sub-Saharan Africa. We found relatively few articles on this topic (25 articles), although we are aware of many more initiatives that have not been documented (Omari & Kouevi, 2023). From the data extracted, it is evident that most of the literature is from studies conducted in Ethiopia, South Africa, Ghana, Nigeria and Tanzania. The range of topics identified in the literature related to female students in STEM higher education includes student success, student resilience, academic achievement, academic performance and retention. Most of the studies (14 articles) are on factors affecting academic performance or student success in STEM in higher education. Fewer studies (11 articles) report on pedagogical interventions and policies that promote and encourage holistic success on the part of female students in STEM. Future research should focus on pedagogical interventions which create inclusive and affirming educational experiences.

Although some of the included literature describes the local contextual landscape, in most cases, the empirical work is not located in relation to the governing policy frameworks. We recommend that future research should be undertaken regarding the extent to which policy, pedagogical practice and research inform one another, and that contextual issues be reported in empirical studies.

Practice recommendations advocated in the surveyed literature include access strategies, career guidance, female role models and mentoring, scholarships, teacher development, interactive and collaborative learning activities, and gender-responsive pedagogies and support systems (see Chapter 1 for application of gender-responsive practices and pedagogy in Zimbabwe). The studies also highlight the policy–practice gap regarding gender in STEM in higher education, with policy interventions taking time and considerable effort to produce results in male-dominated and patriarchal institutional and cultural systems.

Practice can only become gender responsive as a result of sustained reflexive engagements with educators to allow them to examine and improve on their own teaching (Chikunda, 2014). A strong recommendation from this study is that there is a significant need for professional development of academic teaching staff. Such professional development should address two primary goals: (1) increasing awareness of and enabling implementation of active and inclusive pedagogical practices; and (2) facilitating lecturers' acknowledgement of their own biases regarding gender.

A possible framework for future research around women in STEM in higher education in SSA is one provided by Hailu and Parra Gaete (2024). They propose a research tool for comparative scholarship on women's involvement in engineering programmes in SSA that includes five components. These are: (1) understanding the socio-political and historical context surrounding women in engineering (which we have shown is seldom undertaken in our included STEM studies); (2) possible critical discourse analysis of gender-based policies (a significant avenue for future research); (3) more complete enrolment and graduation data for female students (where this data is not available); (4) investigation into the employability of women after graduation (which is beyond the scope of the current chapter, but worthy of investigation elsewhere); and (5) qualitative campus climate surveys of higher education institutions (another valuable avenue for future research). These five components address the policy and practice gaps in the reviewed studies and promise a strong analysis of the issues identified if applied.

This chapter recommends that researchers across the region work collaboratively to research and improve innovative teaching and learning, and to improve women's experiences and outcomes in STEM in higher education in SSA. Gender-responsive pedagogy requires dismantling of biases and stereotypes within the systems and the individuals that make up higher education. Ultimately, inclusive pedagogies have the potential to benefit *all* students in STEM, not just women.

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