Pedagogies of Inclusion

Gender, Pedagogy & STEM in Higher Education in Sub-Saharan Africa

A Scoping Literature Review Report

June 2025

APHRC
African Population and Health Research Center

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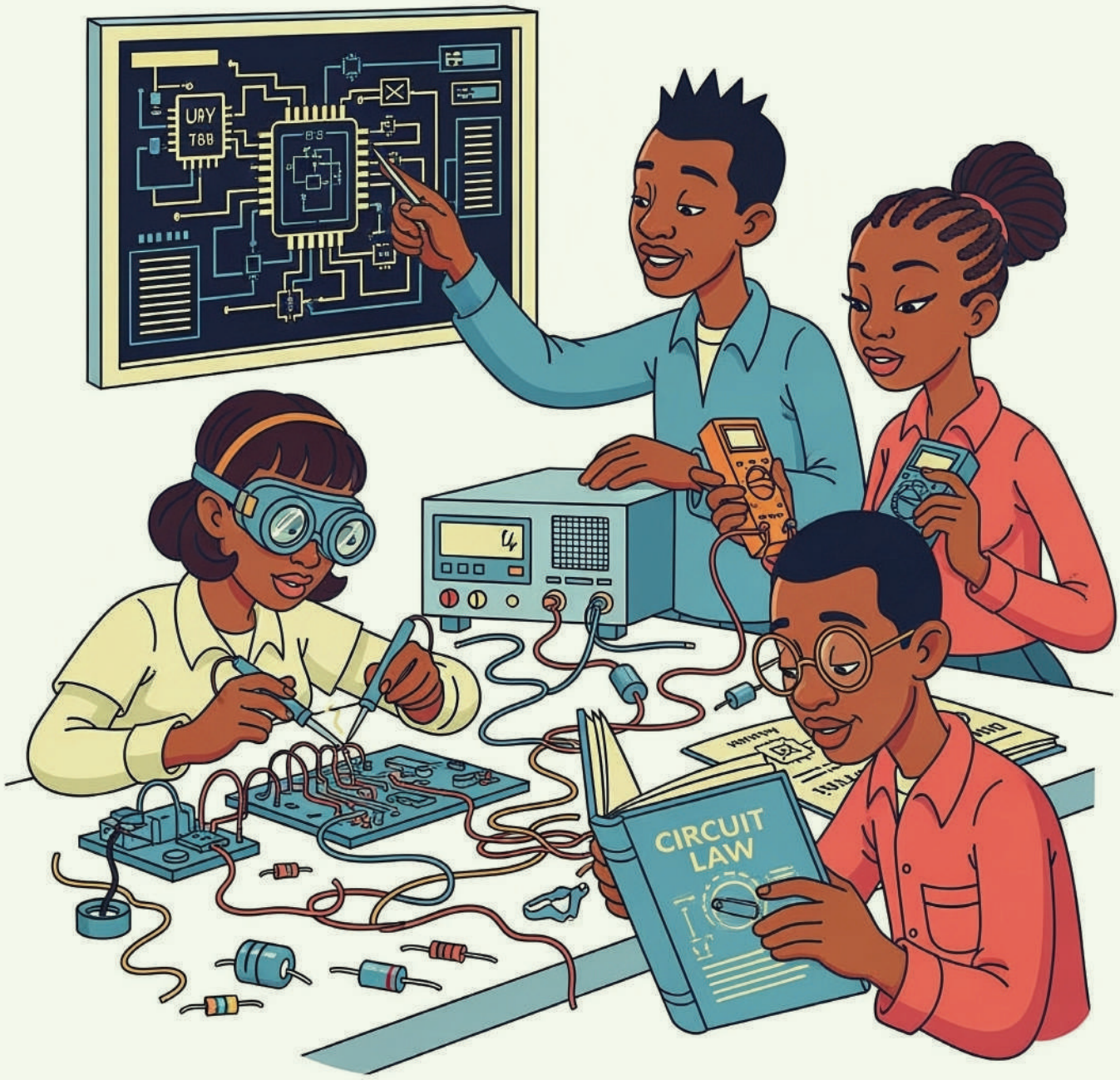
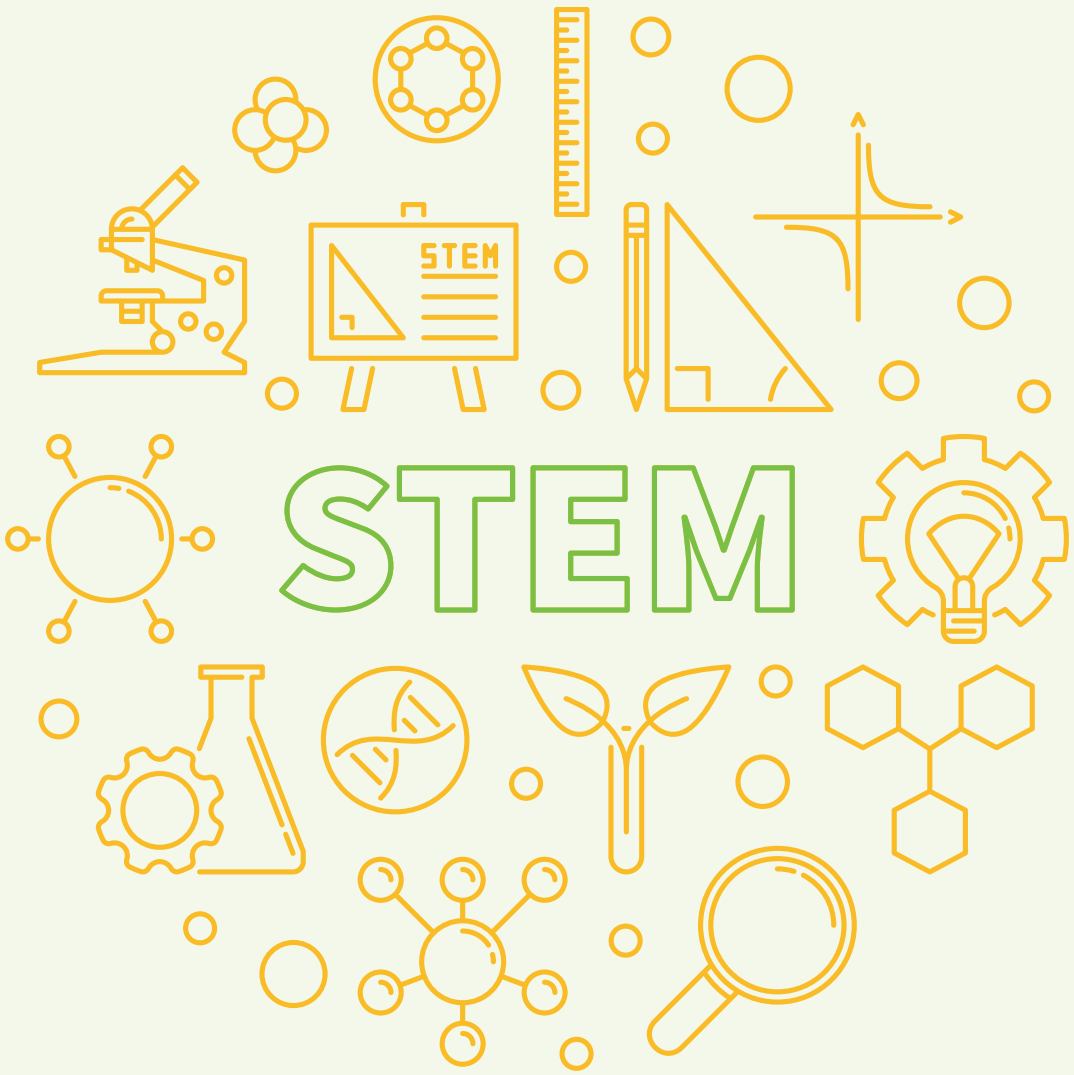


LIST OF FIGURES

Figures are referenced through visual captions in the report. These include:

ACRONYMS

APHRC	African Population and Health Research Center
STEM	Science, Technology, Engineering, and Mathematics
SSA	Sub-Saharan Africa
HEIs	Higher Education Institutions
FAWE	Forum of African Women Educationalists
INASP	International Network for Advancing Science and Policy
AAU	Association of African Universities
TVET	Technical and Vocational Education and Training
SARUA	Southern African Regional Universities Association
IUCEA	Inter-University Council for East Africa
ADEA	Association for the Development of Education in Africa
WITED	Women in Technical Education and Development
WUA	Women's University in Africa
SOTL	Scholarship of Teaching and Learning
5YSP	Five-Year Study Program



EXECUTIVE SUMMARY

The **STEM fields (Science, Technology, Engineering, and Mathematics)** are seen as crucial to economic development and are often prioritized in higher education as a result. However, women remain a minority across many STEM disciplines globally. In sub-Saharan Africa, specifically, while national and regional policies have instigated efforts to infuse a gendered approach into the teaching and learning process, it remains necessary to ascertain what models of success exist in higher education institutions in the region concerning gender-responsive pedagogy, particularly in the STEM disciplines.

This report presents the findings of a scoping review aimed at determining the current state of evidence on the intersection of gender, diversity, inclusion, and pedagogy in STEM-focused disciplines in sub-Saharan African higher education institutions. The scoping review was conducted using relevant search terms in well-recognized databases to identify literature on pedagogical factors that impact women's participation in STEM-related undergraduate programs in sub-Saharan Africa. The method follows Westphaln et al.'s implementation of Arksey and O'Malley's six-stage framework for conducting a scoping review, which includes a consultation exercise integrated across all stages in the form of stakeholder engagement. A total of 98 texts were included in the final dataset.

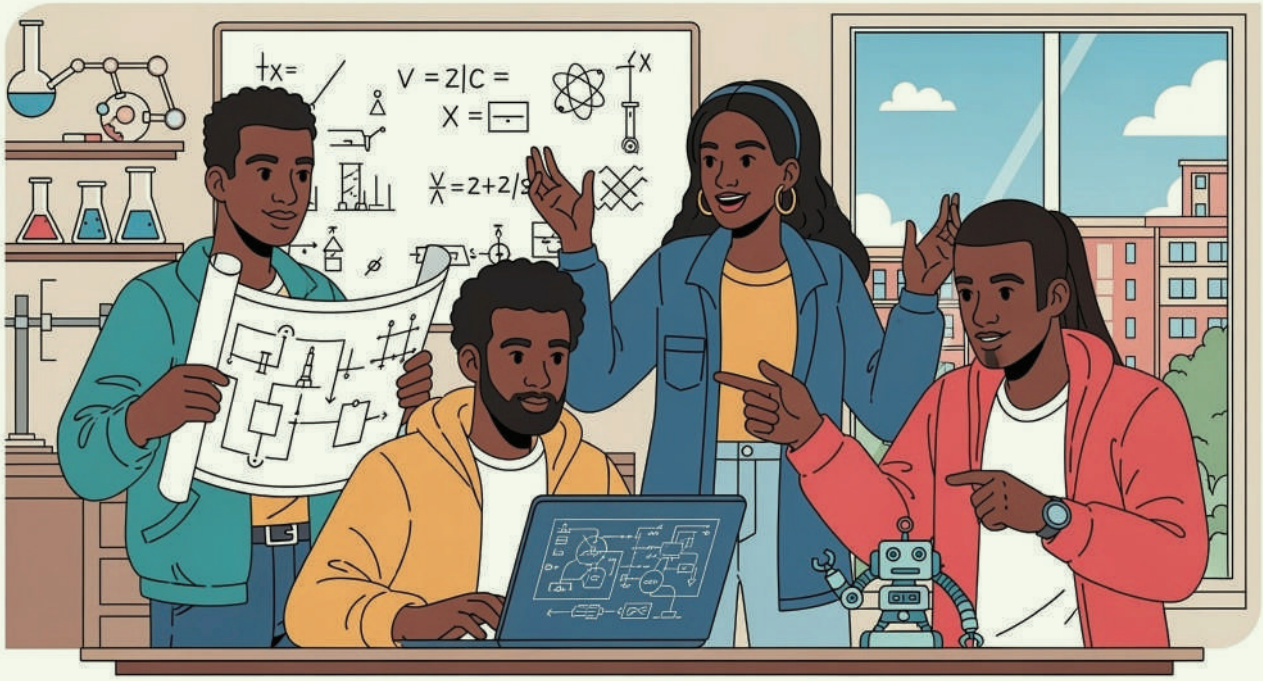
Synthesis of the findings of these studies suggests there is a need for enhanced teaching, learning and assessment strategies to foster more inclusive academic environments. These strategies may include:

1. Peer tutoring and mentoring, which is shown to be particularly beneficial for female students;
2. Problem- and inquiry-based learning, which may encourage more equal participation of male and female students in collaborative settings;
3. Blended learning and e-learning strategies, which may provide women with better opportunities to balance education with caregiving responsibilities.

The report reveals that such strategies are already used to good effect in bridging courses and extended programs. However, it is argued that to enhance their impact, these active learning strategies should be integrated into curricula at all levels and not isolated to add-on programs or courses.

Recommendations are made regarding the need for lecturer training on gender-responsive teaching and gender sensitivity. It is also recommended that the promotion and development of quality scholarship of teaching and learning in sub-Saharan Africa may raise the status of teaching and learning in higher education, surface effective practices being implemented, and provide an empirical basis to make evidence-informed decisions about teaching and learning policy, practice and strategy. This has the potential to benefit all STEM students in the region, including women.

There remains a need for research into the extent to which open, distance, hybrid and e-learning programs and institutions offer particular learning benefits for women in STEM, as well as research into the effectiveness of preferential access policies for women, such as lower entry requirements or reservation of places and funding. A significant fulcrum is the nexus of policy and practice in that policies do not appear to have a material impact on classroom pedagogy. As such, policy research may be critical in furthering our understanding of how gender intersects with race, class, ethnicity, ability and other important variables.



INTRODUCTION

Gender and Inclusion in STEM Higher Education in Sub-Saharan Africa

The **STEM fields (Science, Technology, Engineering, and Mathematics)** are seen by many countries as key to economic development (Melak & Singh, 2021). As a result, programs in STEM are often prioritized in higher education, and attempts are made to enhance access to these programs. One factor often cited as important for increasing enrolment into STEM studies is the fact that, globally, fewer women than men enrol for STEM degrees, and retention and graduation rates are frequently unequally distributed between men and women (Engineering Council of South Africa, 2022; Howe-Walsh & Turnbull, 2014; Ysseldyk et al., 2019). Women remain a minority across many STEM disciplines globally, including physics, mathematics, and engineering (UNESCO, 2024). This underrepresentation limits the diversity of perspectives and talent needed to address complex development challenges.

In South Africa, fewer than 10% of students who complete secondary school qualify to study engineering.

(Engineering Council of South Africa, 2022).

Globally, the average percentage of women among STEM graduates is 35%, a finding consistent across most world regions (UNESCO, 2024). 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., 2021), and women complete advanced degrees at a lower rate than men (Fisher et al., 2020). Sub-Saharan Africa (SSA) has a similar average female participation rate in STEM as the global average, but shows significant variation between countries (UNESCO, 2024). Variations are also notable within STEM disciplines. For example, in Benin's School of Polytechnic (Engineering) (EPAC) "out of the eight engineering programs offered, female enrolment was highest in Civil engineering (35%) followed by Computer and Telecommunication (25.6%) and Electrical (20.2%) with chemical engineering (5.8%) being among the least" (Omari & Kouevi, 2023, p. 2). These disparities between countries and disciplines underline the importance of considering how women's participation in STEM interacts with cultural and political contexts.

In Ethiopia, government mandates require that 70% of all university enrolments are in the STEM fields.

(Melak and Singh, 2021).

"Women's experiences – along with men's experiences – should inform and guide the direction of engineering and technical innovation".

(Hill et al., 2010: 92).

To increase the participation and retention of women in STEM in higher education, it is necessary to first 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). Socio-cultural perceptions often construct STEM as a masculine domain (Namatende-Sakwa, 2018; Onyeocha, Ukwuoma, & Onyeocha, 2023) and inhibit the participation of women in these fields. Should they attend university, women face a lack of female role models in some STEM fields, and some female engineering students report being intimidated by 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). Female students in STEM fields may also be alienated by the teaching approaches used and by the attitudes of both their educators and male classmates, who often underestimate their achievements and abilities (Chapin et al., 2020).

"We African girls and women deserve to study science. Science needs us."

- Armanda Kouassi (2016)

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, 2024: p2).

National and regional policies have instigated efforts to infuse a gendered approach into the teaching and learning process. For example, 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 pedagogical framework for HEIs (Chapin et al., 2020). About two decades earlier, the Association of African Universities (AAU) (2006) produced a similar toolkit on mainstreaming gender in higher education. These efforts emphasize the importance of addressing gender inequalities that affect women's learning by promoting gender-responsiveness in curriculum design, teaching, and assessment. These frameworks were meant to be integrated into existing educational structures and practices, with a focus on building capacity for both lecturers and students to become gender-responsive professionals.

Given these efforts, it is necessary to ascertain what models of success exist in Africa's higher education institutions concerning gender-responsive pedagogy, particularly in the STEM disciplines. This remains important as there is a growing need for STEM educators to focus on the "whole student" rather than only on STEM knowledge and skills (Winberg et al., 2018). This calls for capacity-building of university educators, as their pedagogical practices may perpetuate the gender divide. Chapin et al. (2020) propose the adoption of a gender-responsive pedagogy in the development of curriculum, classroom management and student assessment. For example, research on group composition in teamwork projects suggests that group work in STEM programs should be accompanied by teaching and learning strategies that aim to challenge the prevalence of gender stereotypes and implicit biases (Aeby et al., 2019). Similarly, there may be gendered differences in the ways in which male and female students interact with technology and computers, which have implications for online and hybrid teaching and learning (Hanham et al., 2021). It is essential to note that to effectively nurture the "whole student", it is crucial to examine and address socio-economic and cultural barriers that hinder gender equity and inclusion.

Speaking from her experience growing up in Cote d'Ivoire 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.

Kouassi (2016),

AIM

It is important to understand how, and to what extent, gender-inclusive pedagogies are enacted within individual institutions and classrooms in the sub-Saharan African higher education space. As such, the purpose of this scoping review is to determine the extent and range of literature on this topic. The scoping review determines the current state of evidence on the intersection of gender, diversity, inclusion, and pedagogy in STEM-focused disciplines in sub-Saharan African higher education institutions. In doing so, it seeks to inform development partners and policymakers about existing pedagogical interventions for gender inclusion, as well as identify areas that require further attention and investment.

This report provides an overview of the current evidence on gender-responsive pedagogies in Africa, highlights opportunities for policy intervention, and informs policy and research recommendations. The goal of this review is to inform a collaborative research agenda on how pedagogical practices can address issues of gendered exclusion in STEM disciplines within higher education institutions in sub-Saharan Africa.

Research Question

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

METHODOLOGY

This report addresses the research aim and question via a scoping review of the literature emanating from sub-Saharan Africa. The rationale for focusing on this region is not because the problem is any better or worse in SSA, but because literature from this region is limited and difficult to isolate within the large body of global literature on gender-inclusive pedagogy. Additionally, surfacing the literature from Africa may help fill some of the context-specific knowledge gaps that exist, both for addressing the problem within the region and more broadly.

We conducted a scoping review, applying relevant search terms in well-recognized databases to identify the relevant literature on pedagogical factors that impact women's participation in STEM-related undergraduate programs in sub-Saharan Africa. We utilize Westphaln et al.'s (2021) implementation of Arksey and O'Malley's (2005) six-stage framework for conducting a scoping review. Our preference for this framework is driven by its inclusion of a consultation exercise, which is integrated across all stages through stakeholder engagement.

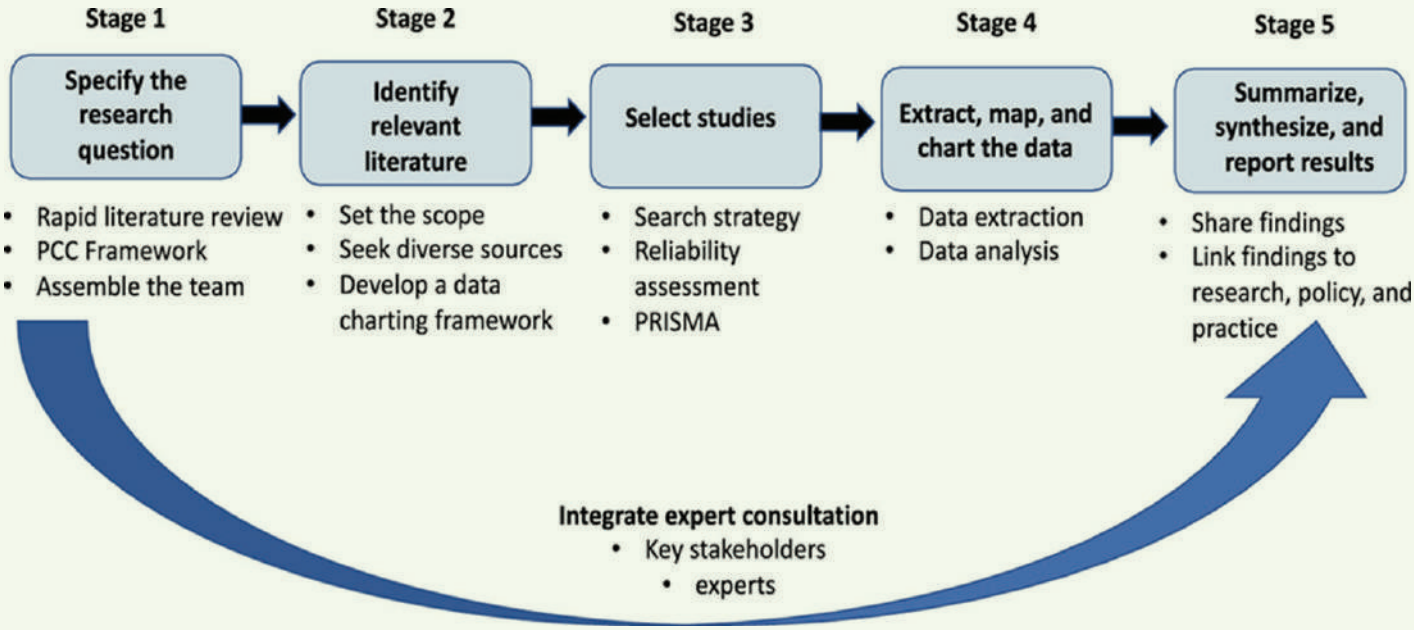


Figure 1: Important Steps in a Scoping Review: Westphaln et al.'s (2021) Adoption of Arksey and O'Malley's (2005) Scoping Review Framework

Stage 1 - Identifying the Research Question

The research question guiding the study was predetermined during the earlier stages of writing the proposal: "What is the current state of evidence on the intersection of gender, diversity, inclusion, and pedagogy in STEM-focused disciplines in African higher education institutions?"

Stage 2 - Identifying Relevant Studies

In this stage, we identified relevant literature to answer the research question. We identified five key concepts in the research question, from which we developed a search strategy to set the scope for the review: sub-Saharan Africa, higher education, STEM, gender, diversity and inclusion, and pedagogy. Each concept was expanded using related terms. For example, we used terms such as university, college, tertiary education, and others related to higher education. The finalized search strategy is shown in Appendix A: Technical Notes on Methods.

Using the search strategy developed, we conducted an electronic search in six databases: Web of Science, Scopus, ProQuest Central, ProQuest Dissertations and Theses, ERIC, and EBSCOHost. The search yielded 13,995 results, from which 5,602 duplicates were removed, leaving 8,393 results.

Stage 3 - Study Selection

In the study selection process, the 8,393 results were screened in three stages to determine the sources of evidence that would answer the research question: title screening, abstract screening, and full-text screening. The three-stage process was consultative and done iteratively. Inclusion criteria were developed and revised at each stage to ensure that only search results pertaining to undergraduate STEM higher education in sub-Saharan Africa were included, resulting in the finalized inclusion criteria shown below.

Table 1: Inclusion and Exclusion Criteria

Inclusion Criteria	Rationale (and Correlating Exclusion Criteria)
The study is located in sub-Saharan Africa.	Sub-Saharan Africa is the focus of the review. Studies undertaken elsewhere in the world were excluded from the review.
The study investigates undergraduate higher education.	This review focuses on undergraduate tertiary education, encompassing 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. For this review, we have included agriculture but have excluded Health Sciences and any other non-STEM discipline.
The study explicitly investigates gender, diversity, and/or inclusion.	Gender is the primary focus of the review. Other dimensions of diversity are also included, as they may provide insight into broader issues of inclusion, while also acknowledging that gender intersects with other identity markers in important ways. Studies that did not reference gender or other markers of diversity and inclusion were excluded from the review.
The study reports on pedagogical interventions or success factors.	Pedagogical interventions are the primary focus of the review. Studies investigating success factors for women are included to provide context. Studies that focus neither on pedagogical interventions nor success factors were excluded from the review.
The study is written in English.	Due to limited resources for translation, we excluded papers that are not written in English. This is a necessary limitation of this review.
The full text is available.	A small number of studies were excluded because we were not able to access the full text.

Because our focus was on reasons to include rather than exclude, we categorized the included results. Literature was included 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 that focused on gender as opposed to those that investigated other dimensions of inclusion.

Stage 4 - Charting the Data

At this stage, we developed and piloted a data charting form to guide data extraction (details on this process are provided in Appendix A: Technical Notes on Methods). Charting of information involved individual researchers sifting through the full texts and recording information into the finalized data charting form in a manner agreed upon by the researchers. The final data charting form includes the following data items: Author(s); Year of publication; Title of publication; Type of publication; Inclusion category; Study location (country the study is conducted in); Contextual landscape around STEM; Type of STEM; Type of Inclusion; Topic; Study aim and/or research questions; Methodology; Data Collection; Study population and participants; Factors investigated; Intervention type; Outcome of intervention; Results and key findings; and Practice/policy recommendations.

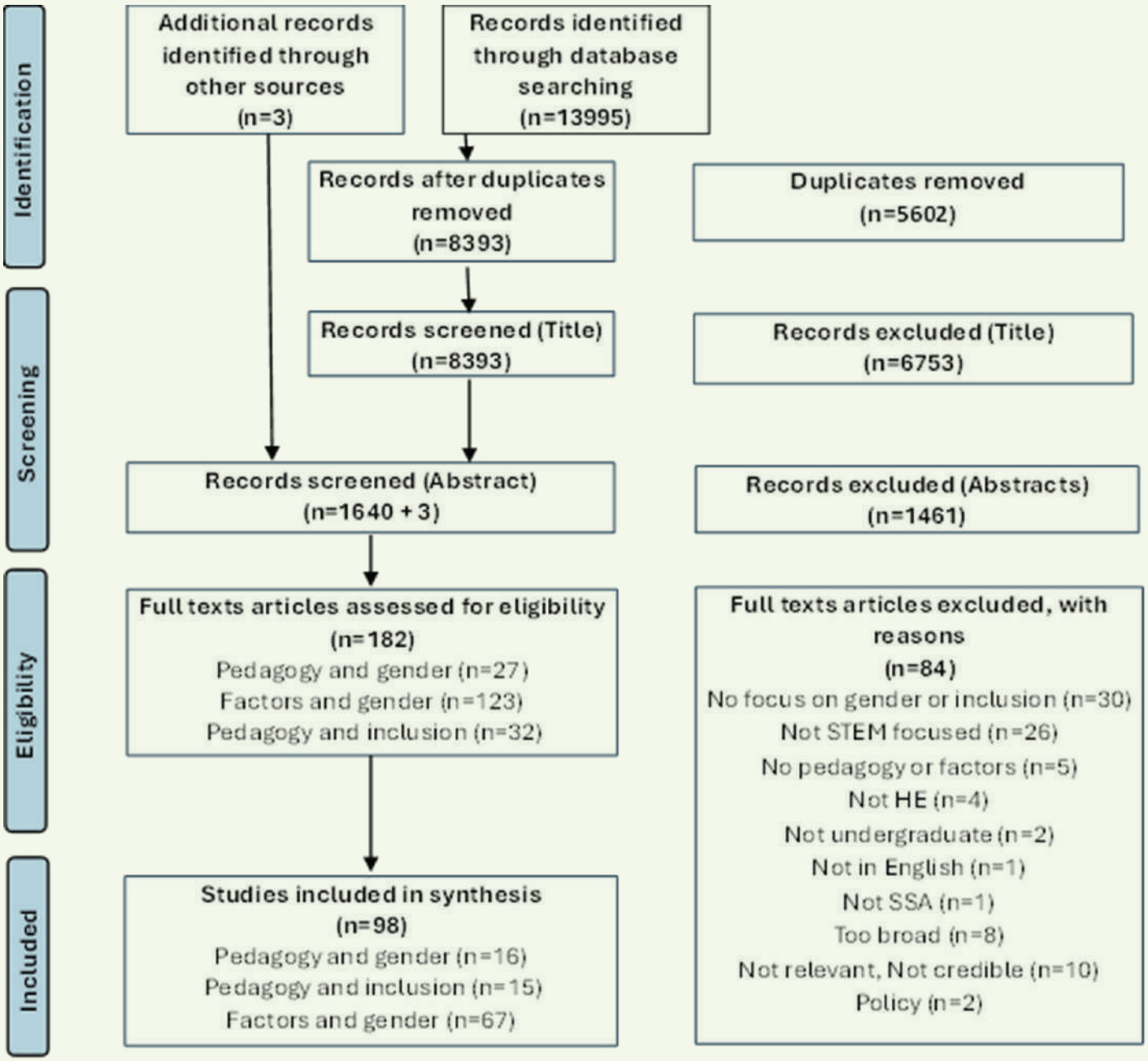


Figure 2: Inclusion and Exclusion of Results: Final Dataset = 98 Included Papers

Stage 5 - Collating, Summarizing and Reporting the Results

At this stage, a quantitative analysis of the studies was conducted through numerical counting to establish the extent and nature of the findings. This method was applied to the information charted regarding: year of publication, type of publication, study location, type of STEM, topic, methodology, and data collection. For the remainder of the information (specifically, the contextual landscape around STEM, Intervention type, Outcome of the intervention, Results/key findings, and Practice/policy recommendations), a qualitative analysis of the literature was undertaken. Each of the information columns was analyzed separately, and themes were identified. These themes were then integrated across the various columns to identify overarching themes.

Stage 6 - Consultation Exercise

Regional higher education convening bodies within sub-Saharan Africa were identified as stakeholders. These were:

- **SARUA** (the Southern African Regional Universities Association)
- **IUCEA** (the Inter-University Council for East Africa)
- **ADEA** (the Association for the Development of Education in Africa)
- **AAU** (Association of African Universities).

These organisations were selected because of their convening power within the region, as each has a large number of member institutions.

Three opportunities for stakeholder engagement were identified: frontline, midline, and endline engagements. The frontline stakeholder engagements are reported by Wakiaga et al. (2024a, 2024b, 2024c, 2024d), and influenced decisions in all stages of the scoping review process. The midline and endline engagements strengthened the review process and sought to expand the impact of the findings. Further details about the stakeholder engagements can be found in Appendix A: Technical Notes on Methods. Three articles were obtained and added to the screening process as a result of the frontline stakeholder engagement.

RESULTS AND DISCUSSION

98 texts were included. Three categories of articles emerged from the search and selection process:

1. **Pedagogy and gender (15 studies)** - these studies report on or discuss pedagogical interventions in STEM in higher education in sub-Saharan Africa 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.
2. **Pedagogy and inclusion (16 studies)** - these studies are located in STEM in higher education in sub-Saharan Africa, and report on pedagogical interventions aimed not at inclusion of women, but at other aspects of inclusion, such as rurality, disability, race, ethnicity, and so on. These studies are included in the scoping review, but only to the extent that they offer pedagogical insights that may also provide avenues for greater inclusion of women in STEM fields in Africa.
3. **Factors and gender (67 studies)** - these studies are located in STEM in higher education in sub-Saharan Africa, but do not specifically involve pedagogy; instead, they report on empirical work that aims to understand the 'factors' that impact on women's success, persistence, or enrollment in STEM programs. These studies are included in the scoping review, but only to the extent that they offer implications for STEM pedagogy in higher education.

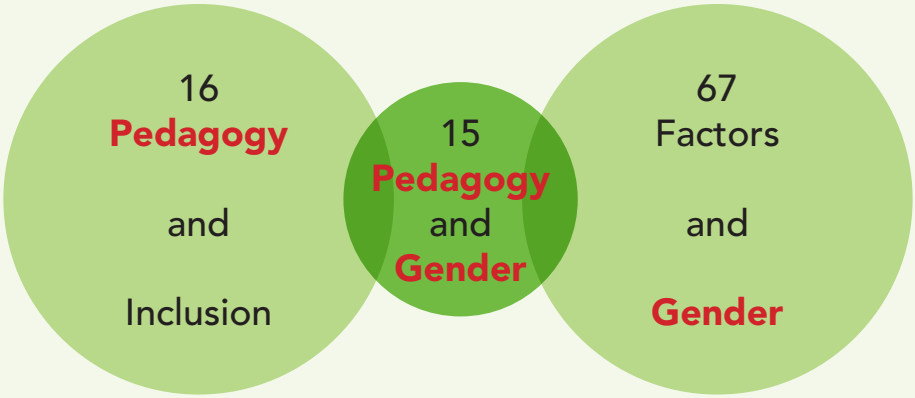


Figure 3: Overview of Dataset: Inclusion Categories

The full dataset of 98 papers, organized by category, is available in Appendix B. The 98 included studies were further quantified through analysis of the type of publication, methodologies employed, year of publication, type of STEM, and study location (country). The results of these quantifications are shown in Figures throughout the remainder of this report. The qualitative analysis of the included studies is structured as follows:

- We begin by reviewing the factors that affect enrollment and retention of women in undergraduate STEM studies. This review summarizes the findings of the 67 studies included in the third category of studies mentioned above. As already mentioned, these studies do not specifically relate to pedagogy (the focus of this review), but are included nonetheless to provide context, as pedagogy alone is necessary but insufficient for fostering gender equity in STEM higher education. In our review of this literature, we focus specifically on implications for STEM pedagogy. As part of this section, we also provide a textbox in which we reflect on how gender intersects with race and (dis) ability as these emerged as significant intersections within the included studies. This section lays the context for the discussion that follows.
- We then discuss bridging courses and extended programmes as pedagogical interventions used to promote the success of women in STEM studies. Such courses and programs emerged as one of the strategies reported in the literature to support women and other marginalized groups in achieving academic success. As part of this section, we provide two text boxes that discuss particular bridging courses or extended programmes presented in the included literature.
- Thirdly, we review active learning pedagogies as an additional theme that emerged from the included literature. These active learning methodologies have the potential to benefit not only the learning of women in STEM studies but also that of students from other marginalized identities. As part of this section, we provide two textboxes that focus on the specific disciplines of programming and mathematics, illustrating how active learning methods benefit women's participation in these particular STEM subjects.
- A fourth theme that emerges from the included studies is the need for professional development of academic teaching staff.
- Finally, we discuss the fact, as synthesised from the included literature, that sexual harassment, discrimination, and cultural stereotypes continue to affect the learning of women in STEM studies.

Factors Affecting Enrollment and Retention of Women in Undergraduate STEM Studies

Much of the literature collected (more than two-thirds, or 67 out of 98, of the full papers) was included because of its focus on factors affecting gender in STEM in higher education in sub-Saharan Africa. This primarily involves an in-depth discussion and analysis of the factors influencing the enrollment and retention of women in STEM undergraduate programs. These factors encompass a range of influences, including personal motivations, socio-cultural factors, institutional policies, and economic conditions. This section briefly summarizes these factors, although they do not directly address the question of this report, which is explicitly focused on pedagogical interventions aimed at promoting the inclusion of women in STEM fields. These factors provide the background to the discussion that follows, which addresses STEM and gender-responsive teaching more concretely.

Figure 4: Overview of dataset: Type of publication

In terms of enrolment, the literature identifies three main groups of challenges. The first of these pertains to motivational and personal factors. These factors include aspects such as vocational self-efficacy, perceived opportunities in the field, social support and the perceived value of STEM careers (Aluede, Imahe and Imahe, 2002). Confidence in STEM subjects, specifically mathematics and physics, is also important (Baguant, 2021; Mwadzaangati and Kazima, 2021; Gronneberg, 2022; Olaitan and Mavuso, 2022). One study (Tandrayen-Ragoobur and Gokulsing, 2022) specifically finds that female students in TVET colleges were motivated to pursue STEM courses in order to acquire the technical and creative skills required to become entrepreneurs, particularly in the construction industry.

A second group of challenges pertains to socio-cultural and psychological barriers. This includes stereotypes and conventional gender roles that discourage women from entering what are perceived to be male-dominated fields, such as engineering (Wuhib, 2017; Thibeault-Orsi, 2022). This is exacerbated by the absence of female role models and lack of exposure to female professionals in STEM, which reinforce the view that such fields are unsuitable for women (Baryeh, Squire and Mogotsi, 2001; Shackleton, Riordan and Simonis, 2006). Perhaps as a result of such factors, Reta, Samuel and Mekonnen (2020) find that mental distress is especially prevalent among female STEM students, who may particularly bear the brunt of financial difficulty, inadequate social support, and interpersonal conflict.

A final group of challenges impacting enrollment in STEM in higher education are educational and institutional barriers. This includes lack of information on engineering and other STEM fields, as well as insufficient career counselling (Baryeh, Squire and Mogotsi, 2001; Lourens, 2015; Melak and Singh, 2021). This set of challenges is seen as perhaps the primary reason that educational reform strategies and policy changes have thus far failed to address the disparate gender enrollment patterns evident (Adepoju, 2022).

The literature further identifies factors that influence retention of female students in STEM courses after they have been enrolled. These are not dissimilar from the factors affecting enrollment. They include social and psychological factors, which include transition factors such as agency and resilience, that affect all students but particularly female students (Hailu, 2018; Patrick, Ramohai & Patrick, 2023). This is because female students may be expected to mute their identities in order to conform to social norms and expectations (Hailu, 2018). Again, familial expectations and social background significantly impact retention of women in STEM (Ochwa-Echel, 2005; Sikhosana, Malatji and Munyoro, 2023).

Similarly, career perceptions and industry expectations also play a role in the retention of women in STEM. Women are more likely to remain in STEM courses if they see clear career pathways and opportunities that align with their interests. Finally, academic and institutional factors affect the retention of women in STEM, which is the focus of the remainder of this report. One study (Kassie, 2018) argues that the gender gap widens as the educational level increases and that female students are more likely to face university dismissal and disciplinary procedures than their male counterparts.

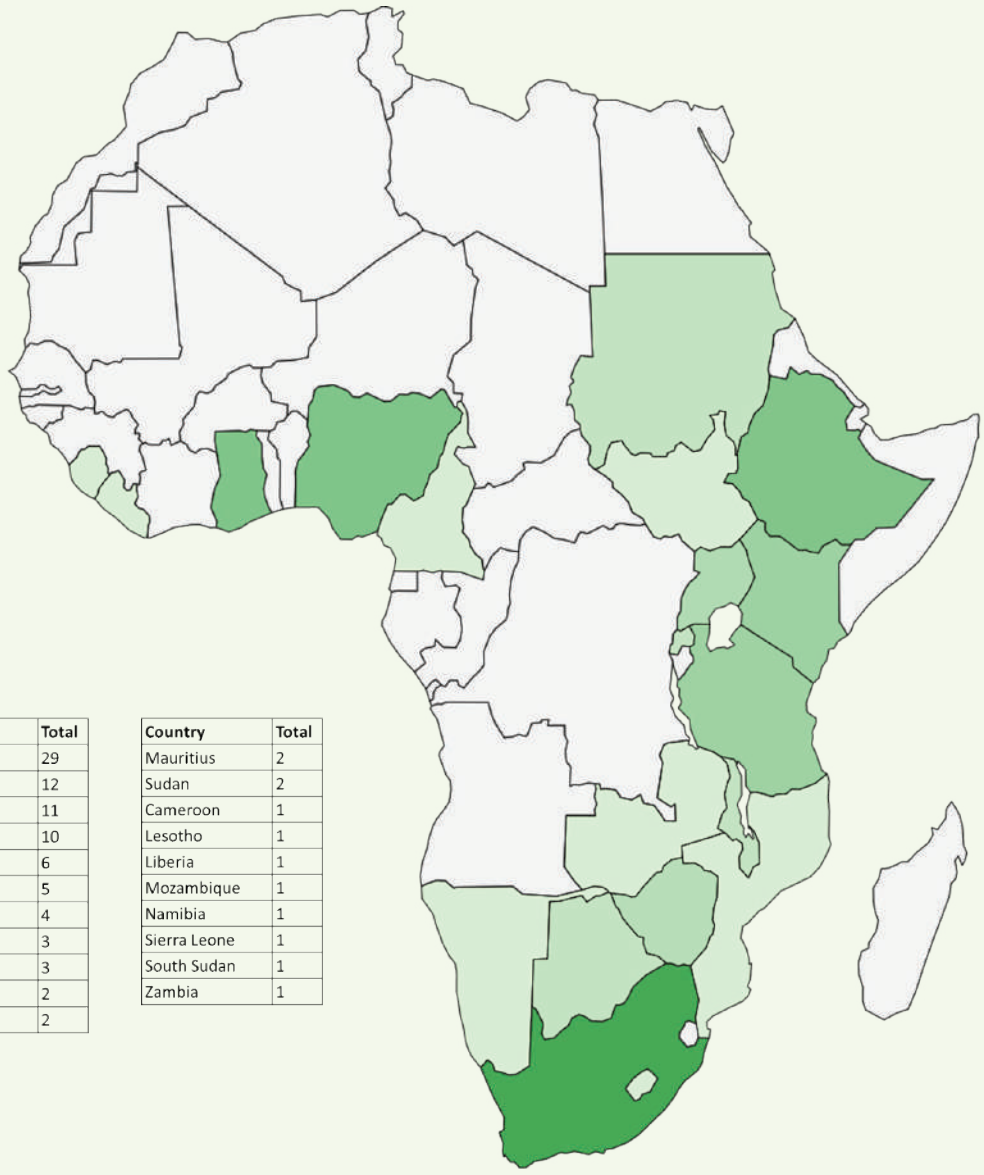
As such, the literature on factors affecting the enrollment and retention of women in STEM suggests that further investigation is needed regarding the specific impact of teaching and learning in higher education on student success, particularly in relation to female students. Further implications of this set of papers, is that there is a need for:

- better career counselling and mentorship at secondary school level,
- increased visibility of female role models in STEM,
- enhanced support mechanisms such as scholarships and funding opportunities for women in STEM, as well as
- enhanced teaching, learning and assessment strategies to foster a more inclusive academic environment. It is this last point that the remainder of this report addresses.

Intersections with Race, Ability and Mental Health

The literature highlights the fact that gender intersects in important ways with race. This is particularly the case in South Africa where gender is often considered in conjunction with, or in relation to, race. For example, Sikhosana, Malatji and Munyoro (2023) investigate the challenges facing Black women studying towards a computer science degree and the coping strategies employed to navigate these challenges. Phume and Bosch (2020) examine the attraction and retention of Black women to the actuarial sciences. Mlambo (2021) examines the under-representation of Black women in engineering.

Elsewhere in Africa, intersections between gender and disability and mental health also become salient. Reta, Samuel and Mekonnen (2020) note that issues of mental distress among engineering students in Ethiopia are particularly severe amongst women. A study in Zimbabwe (Tichauya, Alexander, Paul and Emanuel, 2012) found that universities face several issues in supporting students with visual impairments. This was due to several factors, including a lack of specialized training amongst higher education lecturers, insufficient accommodations in assessment, and barriers in institutional support. A case study from South Africa (Tekane & Potgieter, 2021), on the inclusion of one (male) blind student demonstrates the extent of support needed in the STEM disciplines, including supporting the student to build mental models of sub/micro- or molecular-level phenomena due to limited access to conventional symbolic representations. This was done by providing verbal explanations of visual representations, building models using everyday materials or molecular kits and using tactile artifacts to enhance learning. These adaptations helped this student to succeed academically, but it is also worth noting that such accommodations, when built into programs and curricula, have the potential to support the learning of many students, not just those who are blind.



Country	Total
South Africa	29
Ethiopia	12
Nigeria	11
Ghana	10
Kenya	6
Tanzania	5
Uganda	4
Rwanda	3
Zimbabwe	3
Botswana	2
Malawi	2

Country	Total
Mauritius	2
Sudan	2
Cameroon	1
Lesotho	1
Liberia	1
Mozambique	1
Namibia	1
Sierra Leone	1
South Sudan	1
Zambia	1

Figure 5: Overview of Dataset: Study Location (Country)

Bridging Courses and Extended Programs

The surveyed literature often promotes bridging courses and extended programs as avenues for supporting women (and other marginalized students) in STEM study in higher education. Such courses and programs appear to support women and other marginalized students in overcoming academic, psychological, and social barriers to learning and academic success. These programs aim to enhance foundational knowledge, build confidence, and create pathways for female (or other marginalized) students to thrive in STEM disciplines.

Across all the bridging courses and extended programs cited, active learning strategies are incorporated into teaching methodologies. These learning methods appear to be what differentiates these interventions from traditional curricula. These courses and programs offer holistic academic and psychosocial support, relying on strategies such as group work and collaborative learning, life skills development (including goal setting and self-esteem building), study skills, and career guidance, as well as mentorship and role modeling. Despite the fact that, in some cases, bridging courses and extended programs were of varying effectiveness across disciplines, these interventions offer rich potential for consideration of how these strategies can be incorporated into mainstream curricula, to the benefit of female students, as well as students from other marginalized groups.

If bridging courses and extended programs are valuable tools in increasing women's participation in STEM, their success lies in providing academic support, building confidence, and fostering mentorship. However, to enhance their impact, these active learning strategies should be integrated into curricula at all levels, rather than being isolated to add-on programs or courses. It is to this point that the report will now turn.

Bridging Courses as a Gateway to STEM

The Girls in Biotech Project (Gbande et al, 2021)

Located in Ghana, the Girls in Biotech project is a capacity-building program that aims to expose young women to core biotechnology concepts such as DNA, gene expression, gene therapy, and laboratory techniques. The program was implemented in two phases with 80 participants: a five-day, virtual training for high school and tertiary students, followed by a five-day, in-person boot camp. The outcomes of the program were that participants displayed improved performance, greater confidence and increased motivation to pursue STEM careers. Some trainees mentioned that the fears they had about pursuing careers in science had been demystified following the program.

ICT BootCamp (du Plessis and Janse van Rensburg, 2006)

Based in South Africa, the ICT BootCamp project provides an entry-level certificate in Information and Communication Technology (ICT). 69 students were enrolled in the program, of which 48 were included in the research. This program is not aimed at women in particular but rather seeks to accommodate students with diverse linguistic backgrounds. The program includes an English proficiency module to enhance language skills, facilitating better articulation into higher diploma programs. The language intervention program positively contributed to the success rate of students once enrolled for Programming 1. The program demonstrates the effectiveness of supporting diverse learners to enter STEM disciplines.

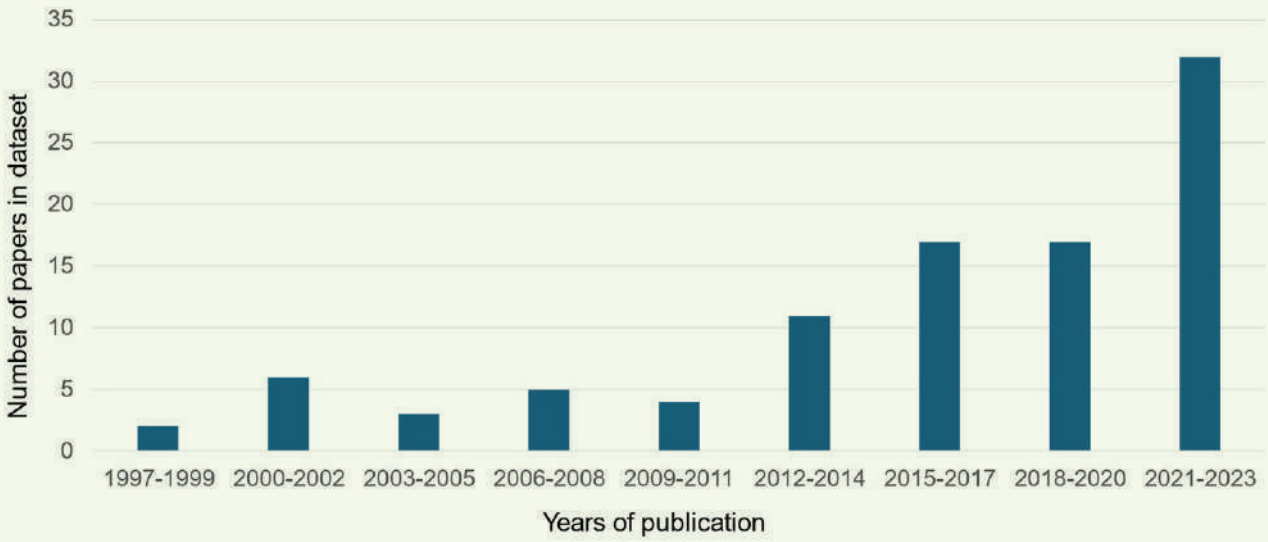


Figure 6: Overview of Dataset: Year of Publication

Extended Programs: Enhancing Retention and Success

ASPECT: Academic Support Program for Engineering in Cape Town (Jawitz and Scott, 1997)

ASPECT is a five-year engineering curriculum where the first two years of a traditional four-year program are extended over three years. Additional learning activities and intensive support are offered in the first year. This is shown via longitudinal retention studies used to monitor the throughput in the engineering degree programs offered. Overall, no significant difference was found in the retention rates of ASPECT and non-ASPECT students. The overall retention rate of the sample of students was found to be 64%, with black students having significantly lower retention rates than white students and female students having significantly lower retention rates than male students. Engineering discipline, race and gender had a significant effect on student retention. ASPECT students performed significantly better in electrical engineering, particularly in the case of female students.

Five-Year Study Program (5YSP) at the University of Pretoria (Steyn, 2005)

The 5YSP at the University of Pretoria spreads the first two years of the four-year engineering degree over three years, and is designed for students who do not meet the direct entry requirements or are academically at risk. As part of the program, additional academic support is provided, including tutoring by senior engineering students. The program appears to demonstrate improved performance, particularly in mathematics, and retention of students. This is based on longitudinal study of academic performance of first-time entering engineering students who enrolled at the University of Pretoria in 2000 and compares performance of 5YSP students with that of first-year engineering students in the traditional four-year program. Gender was not included in the analysis.

Active Learning Methodologies and Pedagogies

Various pedagogical interventions have been implemented to enhance female participation and success in higher education. However, the bulk of these are good teaching practices rather than gender-responsive teaching practices. As such, they demonstrate that good teaching has the potential to benefit all students, not just female students or students from other marginalized groups.

One strategy employed in the literature is peer tutoring and mentoring (Maitland and Lemmer, 2011; Makola, 2017), which is shown to be particularly beneficial for female students (Garwe and Chikwiri, 2021), who often rely on networks of friends and mentors to build confidence and study strategies (Potter, van der Merwe, Kaufman and Delacour, 2006). Part of these mentorship programs is also the need to provide and promote role models, which is the explicit goal of initiatives such as the Global Mentorship Initiative (https://globalmentorship.org/) and the African STEMinist foundation founded by Dr Zamambo Mkhize.

Another strategy employed is problem- and inquiry-based learning. Problem-solving strategies have been shown to improve female students' conceptual understanding and motivation, particularly in subjects like physics (Shishigu, Hailu and Anibo, 2017). Inquiry-based learning is also argued to encourage more equal participation of male and female students in collaborative settings (Maitland and Lemmer, 2011; Aidoo et al, 2022).

Finally, blended learning and e-learning strategies are also promoted as offering potential for greater (gender) inclusion (Sanga, Magesa, Chingonikaya and Kayunze, 2013; Johnson, Abia and Quest, 2016). In the stakeholder engagements, in particular, the view was expressed that online and distance learning allows women to balance education with caregiving responsibilities. The prevailing view is that integration of cellphones, computers, and mobile applications (e.g., WhatsApp, Facebook) enhances access to academic and emotional support networks for female students.

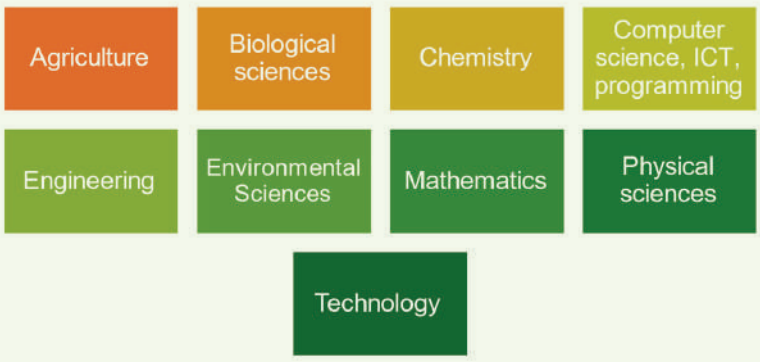


Figure 7: Overview of Dataset: Types of STEM Studied

The Case of Programming

Particular attention has been given in the selected literature, as well as in the stakeholder engagements held, to efforts to improve female students' engagement and achievement in programming. These efforts have explored specific pedagogical approaches, particularly 'constructionist' learning methods (Campbell et al, 2023) and collaborative learning strategies in the form of pair programming (Mitchley, Dominguez-Whitehead and Liccardo, 2014).

Campbell et al (2023) report that studies conducted at two different polytechnics in Nigeria yielded mixed results regarding gender disparities in programming performance. In one study, gender was not a significant factor in programming achievement, suggesting that academic background and institutional context may minimize its impact. However, in another study, male students demonstrated greater improvement in programming scores, highlighting potential gender-related disparities that vary by institutional setting.

The experimental groups in both studies used a Constructionist Scratch approach, where students worked on projects of personal interest, collaborated in teams, and received instructor guidance while engaging in hands-on learning. The absence of traditional lectures encouraged exploration, creativity, and teamwork. Projects ranged from simple animations to interactive games and national anthem recitations. This approach led to significant improvement in student achievement, especially in external assessments. The experimental group outperformed the control group, emphasizing the effectiveness of hands-on, student-driven learning.

The control groups followed a conventional programming curriculum, which included structured lectures, worked examples, and individual programming assignments in Visual Basic. While these students also had lab sessions, they worked independently rather than in collaborative settings. While the control group showed improvement in internal tests, they did not perform as well as the experimental group in external evaluations. This suggests that traditional lecture-based programming instruction may be less effective at fostering deep learning and practical problem-solving skills.

> **Our exploration of gender dynamics within constructionist Scratch programming achievements underscores the need for an inclusive and context sensitive approach. Educators and policymakers should consider the diverse array of factors that contribute to gender-related disparities in programming education. By identifying and recognizing the multifaceted nature of gender effects, the community may be able to develop targeted strategies that promote equitable programming education and create an environment where all students can excel, regardless of their gender.**
>
> **(Campbell et al, 2023)**

Mitchley, Dominguez-Whitehead and Liccardo (2014) report on an intervention for female students based on pair programming, where students work together on graded programming tasks. About 72% of female participants found this approach helpful, as it:

- allowed them to share the workload and discuss solutions collaboratively,
- boosted confidence by providing peer support, and
- improved overall performance in programming.

These two examples demonstrate that interventions designed to support female students in programming must address multiple factors, including pedagogical methods, collaborative learning opportunities, access to technology, and institutional strategies.

The Case of Mathematics

Mathematics also emerged as a particular point of intervention within the STEM disciplines, many of which are heavily reliant on mathematics as a foundational discipline. Some research suggests a statistically significant difference in mathematics performance between male and female students, with male students performing better (Polaki and Nenty, 2001). In one case, it is shown that gender has a significant effect on mathematics anxiety, with women experiencing higher levels of anxiety in relation to mathematics (Awofala & Odogwu, 2017).

In one study (Kebede, 2023), quantitative investigation found that female students generally have a positive attitude toward mathematics across cognitive, affective and behavioral dimensions. Nonetheless, this positive attitude was undermined by several factors, which emerged from qualitative questionnaires and interviews with female students:

- student-related issues: negative perceptions about mathematics, lack of time management skills, and poor foundational knowledge in the subject;
- teacher-related issues: a belief that mathematics is inherently difficult, ineffective teaching methods and assessment techniques, lack of instructional media use, and poor time management by instructors;
- peer-related issues: negative perceptions among peers and a lack of cooperation and support from fellow students;
- material resource issues: limited or insufficient availability of necessary learning materials; and
- administration issues: lack of awareness of the need to create a supportive learning environment, as well as large class sizes that may hinder effective instruction.

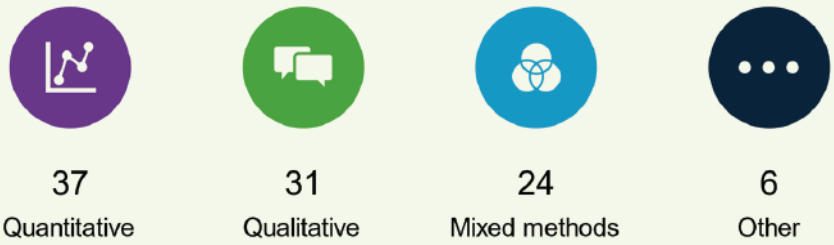


Figure 8: Overview of Dataset: Methodologies Employed

Professional Development of Academic Staff

The primary finding emerging from the scoping literature review is the need for improved integration of gender-responsive teaching practices in higher education, particularly in STEM fields. While awareness of gender-sensitive pedagogy is increasing among lecturers, a gap remains between theoretical understanding and practical application. There is thus a need for professional development of lecturers in this regard.

Efforts, such as the Women in Technical Education and Development (WITED) programme, have aimed to increase female participation in Technical and Vocational Education and Training (TVET), in part through the professional development of teachers and managers (Najoli, 2019). However, despite these efforts, Najoli (2019) finds that low enrolment and completion rates among women persist, highlighting the need for continuous support mechanisms and further professional development. In contrast, at Women's University in Africa (WUA), successful mainstreaming of gender has been achieved, with 86.2% female participation. This is attributed to various factors, including leadership and staff, as well as supportive curriculum structures, gender-responsive pedagogies and targeted financial support (Garwe and Chikwiri, 2021).

Several factors influence the effectiveness of gender-responsive teaching, but the most notable of these appears to be lecturer awareness and practice. While many educators recognize gender issues, their understanding of these issues remains abstract (Kahamba, Massawe and Kira, 2017). Kahamba, Massawe and Kira (2017) further find that more than 60% of lecturers do not consistently apply gender-responsive practices in their teaching. Such gender-responsive professional development goes beyond classroom pedagogical strategies, and may also address assessment strategies, where the literature suggests that traditional assessment methods may disadvantage female students, whereas alternative assessment strategies may improve their performance and retention in subjects like mathematics (Eshun and Abledu, 2001).

Using Engeström's Activity Theory, Chikunda (2014) has demonstrated that tensions exist within higher education, specifically regarding the structures, tools, and rules governing institutions. These tensions limit educators' ability to engage fully with gender issues. As a result, although institutional policies advocate for gender equity, educators often lack the capacity or institutional support to integrate gender-sensitive practices into their curricula systematically (Chikunda, 2014). Peter et al (2021) similarly find that while fostering entrepreneurship among students can be beneficial, some educators lack the expertise to effectively teach entrepreneurship in a way that empowers female students in particular.

In conclusion, therefore, professional development programs should focus on equipping educators with concrete strategies for implementing gender-responsive pedagogy. They may also focus on equipping lecturers to engage in curriculum reform, where a gender-sensitive curriculum can integrate mentorship, role modeling, and inclusive assessment to improve female student retention. Finally, the literature suggests that universities need to bridge the policy-practice gap by ensuring that gender-responsive strategies are actionable and embedded in institutional culture.

Cultural Stereotypes and Sexual Harassment

The provision of training for lecturers in higher education may also need to extend to broader training on gender sensitivity and sexual harassment. Some of the included research studies indicate that cultural stereotypes about women and sexual harassment of female students remain a challenge. For example, in the Nigerian context, Okeke (2011) discusses the extent of harassment and its impact on the academic experiences of women undergraduates, and aggregates these findings by academic field.

In another study (Tukahabwa, 2018) conducted in Rwanda, the view is expressed that society constructs women as physically and intellectually weak, which prohibits them from entering STEM fields in favor of the arts and social sciences; this, despite the observation that the death of many men during the Rwandan genocide meant that post-genocide Rwanda saw numerous women working as constructors or builders of roads, houses as well as becoming heads of families, which changed the perception of women's roles in society and motivated young women to opt for science subjects not only at secondary school level, but also at university.

In Ghana, Boateng (2016) conducted a grounded theory analysis of the challenges women encounter in entering STEM and identified a three-stage experiential journey undergone by the participants under study: interest creation and development; higher education participation; and career dynamics. Boateng argues that women are met with hostile comments from peers (such as being called a 'witch'), undermining their sense of belonging (through comments such as 'what are you doing here') as well as sexually degrading comments.

This is a crucial area in which the role of institutional gender units and sexual harassment policies and practices must play a key role. During various stakeholder engagements, several institutions across the region reported having such units and policies in place. A next step would be to research the role these units play and the practical implementation strategies associated with these policies. In addition, specific examples of gender-sensitivity training should be investigated, where offered, to gauge the effectiveness of such interventions.

Recommendations for Future Development and Study

Teacher Training on Gender-Responsive Teaching and gGender Sensitivity

> When women 'cross the border' to undertake science programs, they are met with hostilities.
>
> **(Boateng, 2016, 15)**

Higher education lecturers require enhanced training in active teaching methodologies, as well as in issues related to gender-responsive pedagogy, gender sensitivity, and bias. This is a fruitful avenue for both intervention and research. Research into the professional development opportunities afforded to higher education teachers, as well as their further developmental needs, could surface some of the challenges hindering the adoption of active methodologies for teaching and learning. Where gender-responsive pedagogical training exists, research into the effectiveness thereof would help scale up such programs across the region. Development and implementation of training on these matters is a useful point of departure for intervention. Awareness of gender-responsive pedagogies is low, and there appears to be general recognition that staff need training on gender-responsive pedagogy, if it is to become embedded within university pedagogy.

Scholarship of Teaching and Learning

The promotion and development of quality scholarship of teaching and learning (SOTL) in sub-Saharan Africa will not only raise the status of teaching and learning in higher education (in the region and beyond), but will also surface effective practices being implemented and provide an empirical basis to make evidence-informed decisions about teaching and learning policy, practice and strategy. This is a fruitful avenue for both intervention and research. Interventions aimed at developing academics' capacity for engaging in SOTL can increase the quantity and quality of teaching and learning research being created in the region. In terms of research, attention could be given to how SOTL is/is not promoted within institutions. Our scoping review suggests that, at present, the quality and quantity of scholarly inquiry into pedagogies of inclusion (of gender, or other aspects of exclusion) is limited. Where research has been embarked upon, it is often of poor quality and, in extreme cases, subject itself to prejudice and stereotype. Several common-sense assumptions are made in the literature and by the stakeholders involved.

Impact of Open, Distance and e-Learning for Women in STEM

A specific area for research is the extent to which open, distance, hybrid, and e-learning programs and institutions offer particular learning benefits for women in STEM. The participants in our stakeholder engagement consultations expressed the view that there was such benefits, but we were unable to corroborate this with empirical evidence in the form of published research. As such, this appears to remain anecdotal and speculative, rather than grounded in fact. Research into this area could clarify this point and provide direction for the potential benefits of online and hybrid learning options for women in STEM.

Impact of Preferential Access Policies for Women in STEM

In our stakeholder engagements, several institutions in multiple countries reported that preferential access policies had been or were being implemented. These included lower entry requirements for women, as well as the reservation of places and funding for women. Research is required to examine the effectiveness of such interventions. This is particularly important as lowering entry requirements may be counterproductive if not also accompanied by enhanced teaching and learning methodologies. Access needs to extend beyond physical access alone, but should also extend to access to the mechanisms through which success in higher education is achieved.

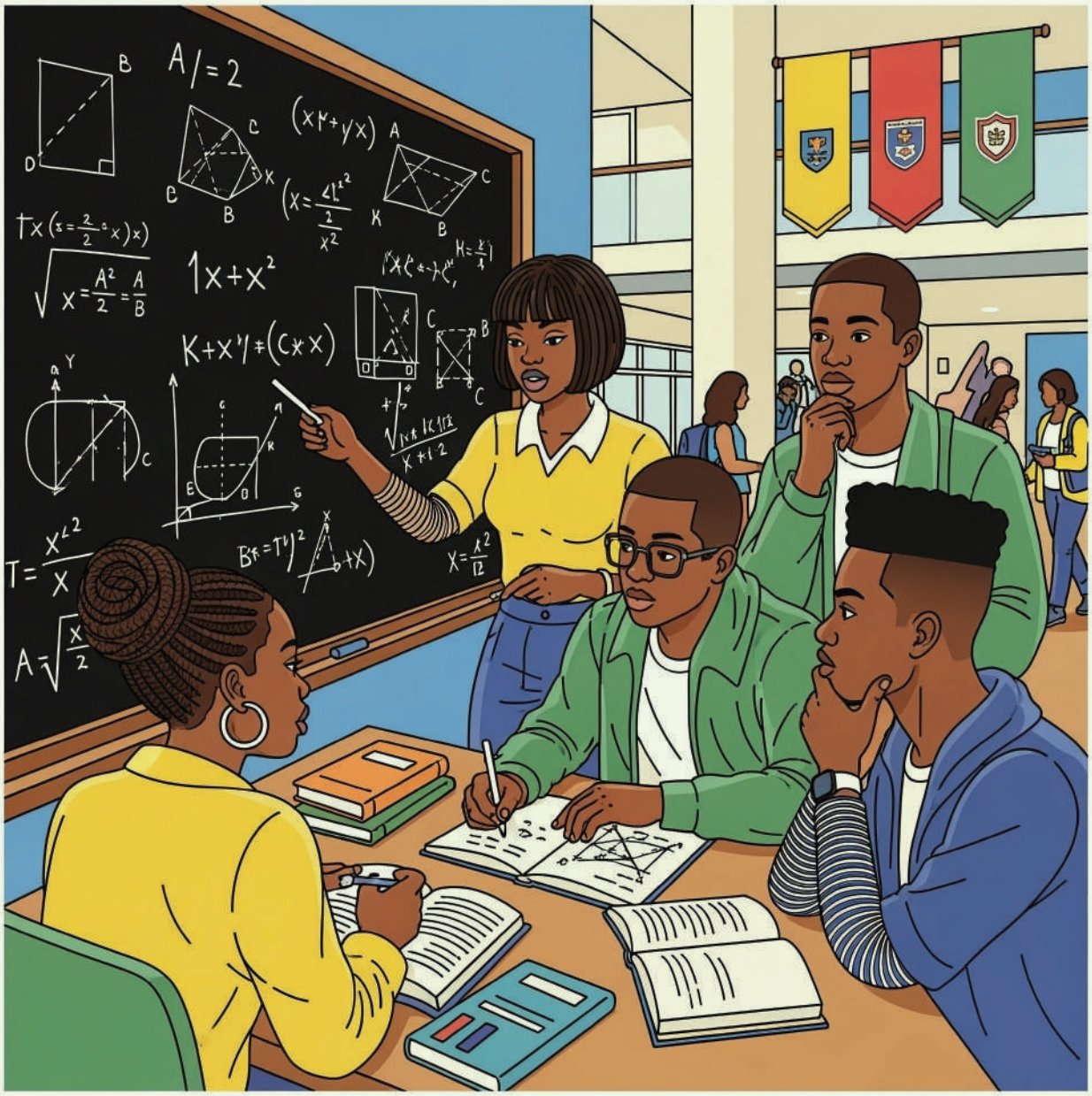
Policy - Practice Gaps

A significant fulcrum is the nexus of policy and practice. Most countries and institutions have policies related to gender. These generally relate to sexual harassment and gender-based violence, but several do also focus on teaching and learning and the need for greater incorporation of gender-responsive pedagogies. However, these policies do not appear to have a material impact on classroom pedagogy, which is a matter of concern as well as a significant opportunity for intervention and research. Policy is critical in ensuring that women are provided with emotional and physical safety on campus, both in terms of physical safety and in terms of the structures aimed at supporting students, including teaching and learning. Moreover, policy research may be critical in furthering our understanding of the important ways in which gender intersects with race, class, ethnicity, ability, and other important variables.

Other Areas for Intervention and Research

Several other areas warrant attention in relation to promoting access for women to STEM in sub-Saharan Africa. In our review, it was clear that the bulk of the literature focuses on traditional universities and that relatively few studies focus on further education, technical education, or vocational education colleges. There is also scope for consideration of the role that mentorship (both formal and informal) might play for women in STEM and for other marginalized students. There is also a need to consider issues of mental health and well-being amongst women in undergraduate STEM studies.

> Gender is not only entwined with other social categorizations … it is the center of intersectionality. This is reflected in the choice of discipline, the choice of STEM discipline, the kind of occupation/career, and basically the conception of women in […] society.
>
> **(Boateng, 2015)**



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APPENDIX A: Technical Notes on Methods

The study was conducted by two teams of researchers: the African Population and Health Research Centre (APHRC) team led the organisation of stakeholder engagement workshops with regional educational bodies, inviting participants from senior levels of academia and government to engage with the topic, while the University of Johannesburg (UJ) team conducted the scoping review and also participated in the stakeholder engagements. The six-stage scoping review process is explained in the methodology section of the report. Here, greater detail on selected stages is provided in order to enhance the transparency and ensure reliability of the findings (Arksey and O'Malley, 2005). This allows others to verify the steps taken, assess the consistency of the process, and judge the trustworthiness of the results. A scoping review does not evaluate the quality of included studies; hence, no statistical analysis is made, and no definitive conclusions can be drawn from the review (Arksey & O'Malley, 2005).

Stage 2 - Identifying Relevant Studies

Finalized Search Strategy

Concept	Search Terms (In Title or Abstract)
African	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 "Cote 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	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 program*" OR "innovative teaching"

In order to specify characteristics of the sources of evidence we were looking for in our search, we also considered the following, in addition to applying the search strategy we developed.

- All types of documents except news media
- All years of publication
- Only material published in English (we acknowledge that this is a limitation of the study, given the dominance of French and Portuguese in some parts of Africa)

Results were extracted into Zotero reference management software, where duplicates were removed. The remaining items were extracted to a Google spreadsheet for screening against the inclusion criteria described in Stage 3.

Stage 3 - Study Selection

The first step involved screening the titles only to exclude all obviously irrelevant results. The results that remained were sent to abstract screening, where we read through the abstracts and decided to exclude articles that did not meet the inclusion criteria. The articles that were identified for full-text screening were then downloaded for full-text review. The full texts were reviewed and screened, and the included texts were categorised. The inclusion criteria were developed and tested to ensure that only search results that pertain to undergraduate STEM higher education in sub-Saharan Africa are included. The inclusion criteria developed during the search were revised at every stage to facilitate the screening exercise, resulting in the finalised inclusion criteria.

Stage 4 - Charting the Data

Stage 4 involved developing a form that would guide data extraction or data charting. We developed a preliminary data extraction framework by first looking at the common or general information that other scoping review studies have included in their data charting forms. We then read 10 primary articles from those that had been selected for full-text review. Based on these initial articles, the more specific information we include was added to the data charting form. Two of the researchers then piloted the data chart independently using a further subset of papers and then discussed their results and ways to record information. Further columns were added as relevant information emerged.

The final data charting form includes the following data items: Author(s); Year of publication; Title of publication; Type of publication; Inclusion category; Study location (country the study is conducted in); Contextual landscape around STEM; Type of STEM; Type of Inclusion; Topic; Study aim and/or research questions; Methodology; Data Collection; Study population and participants; Factors investigated; Intervention type; Outcome of intervention; Results and key findings; and Practice/policy recommendations.

Charting of information involved individual researchers sifting through the full texts and recording information into the finalised data charting form in a manner that was agreed upon by the researchers.

Information Charting Framework

Stage 5 - Collating, Summarizing, and Reporting the Results

ChatGPT was used to produce a draft synthesis of each theme. The prompt given to ChatGPT was as follows: 'Can I upload rough notes on [theme identified]. I would like you to synthesize these notes into a coherent discussion on [theme identified]. Please do not add any extra information and stick only to the notes provided.' In this way, ChatGPT was used to produce a first draft of the theme narrative that was then used as a base for discussion, consideration, and refinement. The ChatGPT outputs per theme were heavily revised, in terms of the structure and writing. In addition, references to the source material were added manually.

Stage 6 – Stakeholder Consultation

For the frontline engagements, five engagements were held, one co-hosted online with each of the four regional convening bodies, and a pilot engagement held at the 4th biennial SOTL in the South conference. Apart from the pilot, these engagements were held online. During the engagements, the project aims and methods were introduced to stakeholders, and four specific questions were posed to participants:

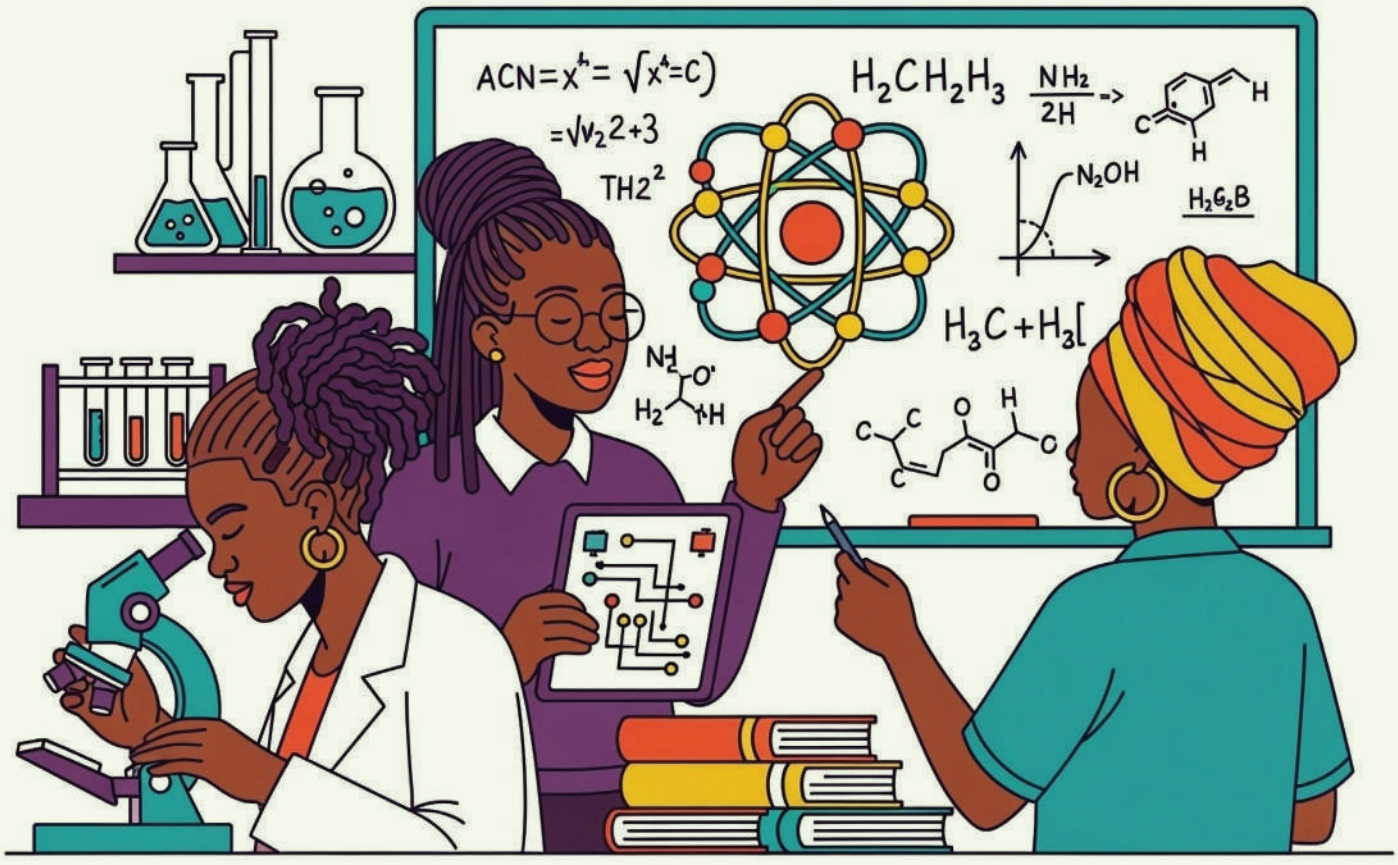
1. What demographic criteria, if any, does your institution use to report on student success? (gender, race, etc)
2. What policies exist that you're aware of with regard to women and inclusion – in your institution and more broadly?
3. What literature (research, reports, theses, 'grey' literature) are you aware of on the topic of women, inclusion, and/or pedagogy in higher education in Africa?
4. Are you aware of any innovative practices – around women, inclusion, pedagogy, and STEM – being carried out at your institutions, – or more broadly?

Participants were invited into breakaway discussions, each moderated by a project team member, wherein these questions were discussed. It was felt that more information may be obtained from participants in smaller groups. The information was captured within each group, using an online shared document, and a further opportunity for plenary feedback and discussion was also provided. Across the five frontline stakeholder engagements, 190 participants attended. Several interesting policies and practices across SSA were identified, and materials to be included in the scoping review were brought to the attention of the research team.

For the midline engagement, a survey instrument was created. This survey instrument was designed based on the practices and policies mentioned in the frontline engagement. The purpose of the survey was to ascertain the extent to which these policies and practices were prevalent across the continent. The survey was sent out through the four convening bodies, to their membership. In total, the survey was completed by 50 participants from across SSA.

The endline stakeholder engagement was held upon completion of the scoping review. The results and outcomes of the scoping review were presented for critical consideration and interrogation in a one-off workshop co-sanctioned by all four regional convening leads, with the purpose being to ensure that the findings presented in this report would be as robust as possible. The endline stakeholder engagement was attended by participants from across the region. In general, the stakeholders expressed approval of the results of the scoping review and did not suggest any additions or amendments to the findings. One comment was made regarding the decision to only include studies in English; this was acknowledged as a limitation as it meant that literature from francophone and lusophone Africa were not included in the scope of the study.

The engagement of policy makers and other key stakeholders throughout the process of conducting the scoping review served to strengthen the review process and the findings. Specifically, the frontline engagement served to obtain feedback on the design of the scoping review as well as to identify literature that might otherwise not have been identified in the formal literature search conducted, while the endline engagement served to validate and disseminate the scoping review findings to relevant decision makers in the SSA region.



APPENDIX B: Included Studies by Category

Pedagogy and Gender (16 Studies)

Aidoo, B., Anthony-Krueger, C., Gyampoh, A. O. G., Tsyawo, J., & Quansah, F. (2022). A Mixed-Method Approach to Investigate the Effect of Flipped Inquiry-Based Learning on Chemistry Students Learning. European Journal of Science and Mathematics Education, 10(4), 507–518. https://doi.org/10.30935/scimath/12339

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Gbande, F. Y., Appiah, J., Ahiataku, S., Boadu, P., Akligoh, H., Abankwa, E., & Alorzukey, S. (2021). Biotechnology as a tool: Empowering women to lead change in Africa. 2021 IST-Africa Conference, IST-Africa 2021. Scopus. https://ieeexplore-ieee-org.uplib.idm.oclc.org/stamp/stamp.jsp?tp=&arnumber=9577003&isnumber=9576831

Kahamba, J. S., Massawe, F. A., & Kira, E. S. (2017). Awareness and Practice of Gender Responsive Pedagogy in Higher Learning Institutions: The Case of Sokoine University of Agriculture, Tanzania. Journal of Education, Humanities and Sciences, 6(2).

Magunje, C., & Brown, C. (2013). From cellphone to computer: University students' use of technology in first year. In Proceedings of the Eighth International Conference on e-Learning (pp.496-502).

Mbano, N., & Nolan, K. (2017). Increasing Access of Female Students in Science Technology, Engineering and Mathematics (STEM), in the University of Malawi (UNIMA). Science Education International, 28(1), 53–77.

Mitchley, M., Dominguez-Whitehead, Y., & Liccardo, S. (2014). Pair programming, confidence and gender considerations at a South African University. In Paths to Career and Success for Women in Science: Findings from International Research (pp. 133–148). Scopus. https://doi.org/10.1007/978-3-658-04061-1_8

Mukagihana, J., Nsanganwimana, F., & Aurah, C. M. (2021). How Pre-service Teachers Learn Microbiology using Lecture, Animations, and Laboratory Activities at one Private University in Rwanda. International Journal of Learning, Teaching and Educational Research, 20(7), 328–345. https://doi.org/10.26803/ijlter.20.7.18

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Peter, F., Eze, S., Osigwe, K., Peter, A., Adeyemi, E., Okologbo, C., & Asiyanbola, T. (2021). Entrepreneurship Education and Venture Intention of Female Engineering Students in A Nigerian University. International Journal of Higher Education, 10(4), 9. https://doi.org/10.5430/ijhe.v10n4p9

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Pedagogy and Inclusion (15 Studies)

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Jawitz, J. & Scott, L. (1997). Who does not succeed in engineering at the University of Cape Town? What can one tell from the retention rate? (01/01/1997, Ed.). Stipes Publishing; inh. https://doi.org/10.1109/FIE.1997.644813

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Jordaan, M., & Jordaan, D. (2019). Diversity in groups-Students' reflection. 123–131. Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85071471559&partnerID=40&md5=1d0bee5079a0132205e9a86914488ba9

Kok, P. J. (2021). The Relationship Between Pre-service Teachers' Spatial Experience and Spatial Visualisation at a Rural-based University. African Journal of Research in Mathematics, Science & Technology Education, 25(1), 103–111. asn. https://search.ebscohost.com/login.aspx?direct=true&AuthType=sso&db=asn&AN=150798035&site=ehost-live&scope=site&custid=s6390179

Kritzinger, A., Lemmens, J.-C., & Potgieter, M. (2018). Learning strategies for first-year biology: Toward moving the "murky middle". CBE Life Sciences Education, 17(3). Scopus. https://doi.org/10.1187/cbe.17-10-0211

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Tekane, R., & Potgieter, M. (2021). Insights from training a blind student in biological sciences. South African Journal of Science, 117(5/6). https://doi.org/10.17159/sajs.2021/8607

Thondhlana, G., & Belluigi, D. Z. (2014). Group work as 'terrains of learning' for students in South African higher education. Perspectives in Education, 32(4), 40–55. Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84924206542&partnerID=40&md5=02f3b156679fff698153946ae85db780

Tichauya, C., Alexander, C., Paul, M., & Emanuel, D. (2012). The Forgotten Tribe in ODL Systems: Challenges Faced by Visually Impaired Students in Institutions of Higher Learning. HURIA: Journal of the Open University of Tanzania, 13(2), 410–421. awn. https://search.ebscohost.com/login.aspx?direct=true&AuthType=sso&db=awn&AN=huria-110869&site=ehost-live&scope=site&custid=s6390179

Factors and Gender (67 Studies)

Abdelbagi, A. M., Sirelkhatim, A. H., Abdelrahman, W. S., Osman, M. E., & Shatir, T. S. (2009). The status of women in physics in Sudan (01/01/2009, Ed.; Vol. 1119, pp. 175–176). American Institute of Physics; inh. https://doi.org/10.1063/1.3137762

Adepoju, T. L. (2022). Management Strategies And Policy Initiatives For Bridging Gender Gap In Science And Technology Education In Nigerian Higher Institutions Of Learning. Bulgarian Journal of Science and Education Policy, 16(1), 61–92.

Adeshina, K. (n.d.). Influence of information sources, needs and gender on information use of science undergraduate students in University of Ibadan, Nigeria. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=12009&context=libphilprac.

Agumba, J. N. (2016). Cross tabulation analysis: Determinants of mathematic success among civil and built environment students. 3(2). https://doi.org/10.14455/isec.res.2016.179

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