

## PERSPECTIVE PAPER

*Special Issue: Women in Contemporary Science in Africa*

# Bridging the gender gap in science, technology, engineering, and mathematics: a perspective on African women's participation and challenges

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### ABSTRACT

Despite significant progress in education and the workforce, gender disparities persist in STEM fields, particularly in Africa. Societal norms, stereotypes, and institutional barriers continue to limit women's participation and advancement in science and technology. This study explores the underlying factors contributing to the gender gap in STEM by drawing on multiple theoretical perspectives, with Social Role Theory and Gender Schema Theory providing the core framework for understanding how cultural expectations and cognitive schemas shape career choices. Building on this foundation, complementary perspectives including the Theories of Gendered Socialization, Peer Groups, and the Theory of Stereotypes, explained how gender norms are reinforced through upbringing, peer influence, cultural narratives, limited mentorship, workplace biases, and lack of access to resources. Yet, many African women have overcome these challenges, making remarkable contributions across STEM disciplines. Their success underscores the importance of mentorship, supportive policies, and initiatives including STEM clubs and media representation in encouraging more women to pursue careers in science and technology. Bridging the gender gap requires a multi-faceted approach that includes educational reforms, equitable workplace policies, government support, and digital learning opportunities. By fostering an inclusive environment, African women can thrive in STEM, drive innovation, and contribute to a more equitable society.

### KEYWORDS:

Africa, Gender Gap, Gendered Socialization, Peer Group, STEM, Social Role, Stereotype Theory, Women in Science

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## INTRODUCTION

Women remain underrepresented in Science, Technology, Engineering, and Mathematics (STEM) globally, with the gap particularly pronounced in Africa. Despite measurable progress toward gender equity, African women continue to face persistent structural and socio-cultural barriers that limit their participation in scientific education and careers. Limited access to quality education, cultural expectations, and deeply embedded gender stereotypes shape women's educational pathways, career aspirations, and professional advancement in STEM fields. These stereotypes often discourage women from pursuing technical disciplines, undermine confidence and self-efficacy, and reinforce institutional biases that restrict progression into senior and leadership roles.

Recognizing the systemic nature of this challenge, the Women for Science Working Group identified the profiling of African women scientists as a strategic priority for the Network of African Science Academies (NASAC) in 2011<sup>1</sup>. Building on this mandate, Ngila et al.<sup>2</sup> provided baseline evidence on women's representation within the membership and governance structures of national science academies affiliated with the InterAcademy Partnership (IAP). Their findings revealed that gender disparities extend beyond individual choices to broader institutional and societal systems reinforced by social norms, educational structures, and media representations, all of which influence perceptions of STEM and shape who is encouraged to participate.

Women remain markedly underrepresented in STEM leadership and governance structures, with women's membership in national science academies frequently falling below 12%. Although female enrolment in STEM education in Africa has increased to approximately 30%, participation remains disproportionately low in fields such as engineering, physics, and computer science<sup>3</sup>. The IAP survey further illustrates variation in women's representation across the continent: 7% in the Academy of Scientific Research and Technology in Egypt, 9% in the Ethiopian Academy of Sciences, and 14% in the Kenya National Academy of Sciences. By comparison, the highest share of women members in science academies was reported in Latin America and

the Caribbean (17%), while globally, women held an average of 20% of governing body positions<sup>2</sup>.

While incremental progress is evident, persistent gender stereotypes, especially those reinforced within social science discourse, continue to weaken women's confidence, limit aspirations in technical fields, and perpetuate institutional exclusion<sup>2</sup>. These dynamics have consequences beyond gender equity, as the underutilization of women's scientific talent undermines innovation, scientific advancement, and economic development by narrowing the diversity of perspectives and reducing the available research workforce<sup>4</sup>.

Addressing gender disparities in STEM is both a social justice and development imperative, as expanding women's participation enhances innovation, strengthens problem-solving capacity, and supports long-term socio-economic growth while also enabling the identification of structural and socio-cultural barriers that must be addressed to bridge persistent gaps in participation and leadership through coordinated action across education systems, policy frameworks, mentorship structures, and cultural narratives.

Against this backdrop, the present study examines the historical and contemporary contributions of African women across scientific disciplines and analyses how gender stereotypes shape educational pathways, career trajectories, and sustained participation in STEM. It further investigates the role of institutions, media representations, and broader cultural narratives in reinforcing these patterns, situates their impacts within wider socio-economic contexts, and identifies evidence-based policy and strategic interventions to promote equitable participation, retention, and leadership of African women in STEM.

## METHODS

This study adopts a mixed-methods approach that integrates a qualitative literature review with quantitative analysis of secondary data to examine women's participation in STEM in Africa. The qualitative component consisted of a targeted literature review using Google and Google Scholar to identify peer-

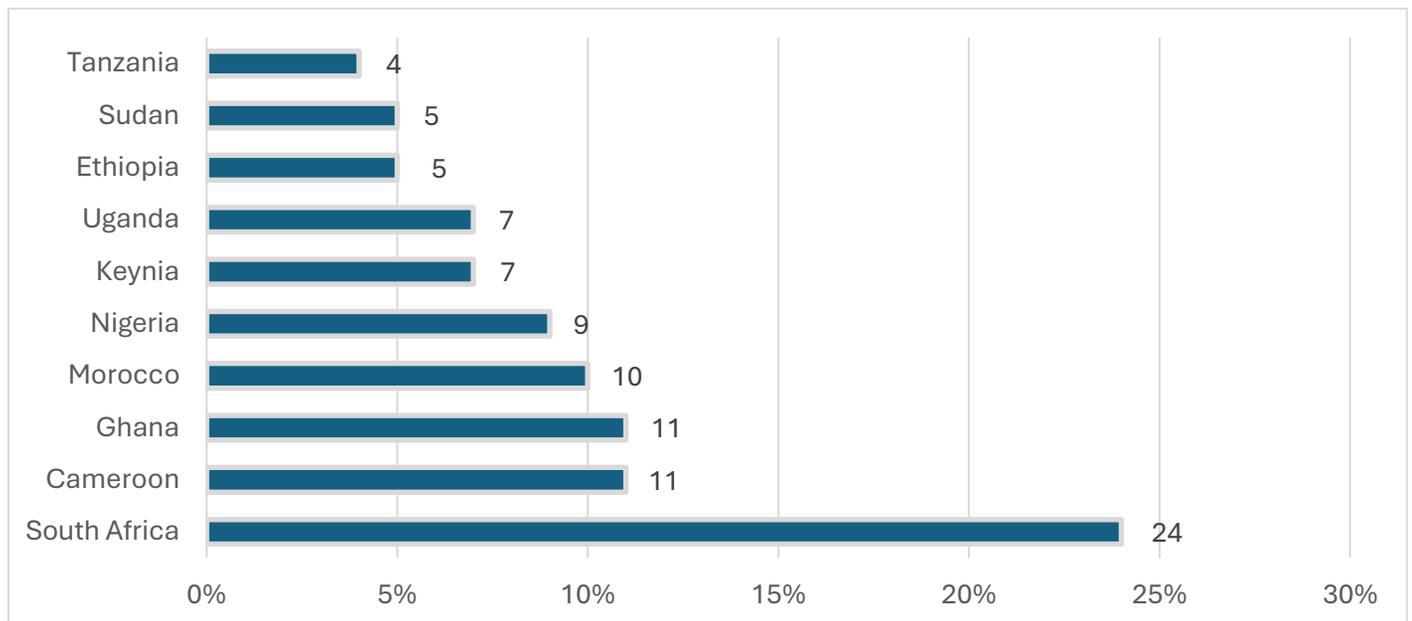
reviewed journal articles, institutional reports, and policy documents on African women’s careers in STEM. Key search terms included “African women in science,” “gender and science policy in Africa,” and “women’s participation in scientific academies.” Priority was given to sources published within the last 15 years to ensure relevance and analytical rigor.

The quantitative analysis uses secondary data from the 2014–2015 global survey of Inter Academy Partnership (IAP) member academies. The survey was coordinated by the Inter-American Network of Academies of Sciences (IANAS), which collected data from its 19 member academies in the Americas, and the Academy of Science of South Africa (ASSAf), which gathered responses from IAP member academies in other regions. While the questionnaires were not identical, both explored three key areas: women’s share of academy membership, their role in academy governance, and policies or initiatives supporting women’s participation<sup>5</sup>.

The survey relevant to this study was conducted by ASSAf between June and September 2014, with final responses received in April 2015. The SurveyMonkey-

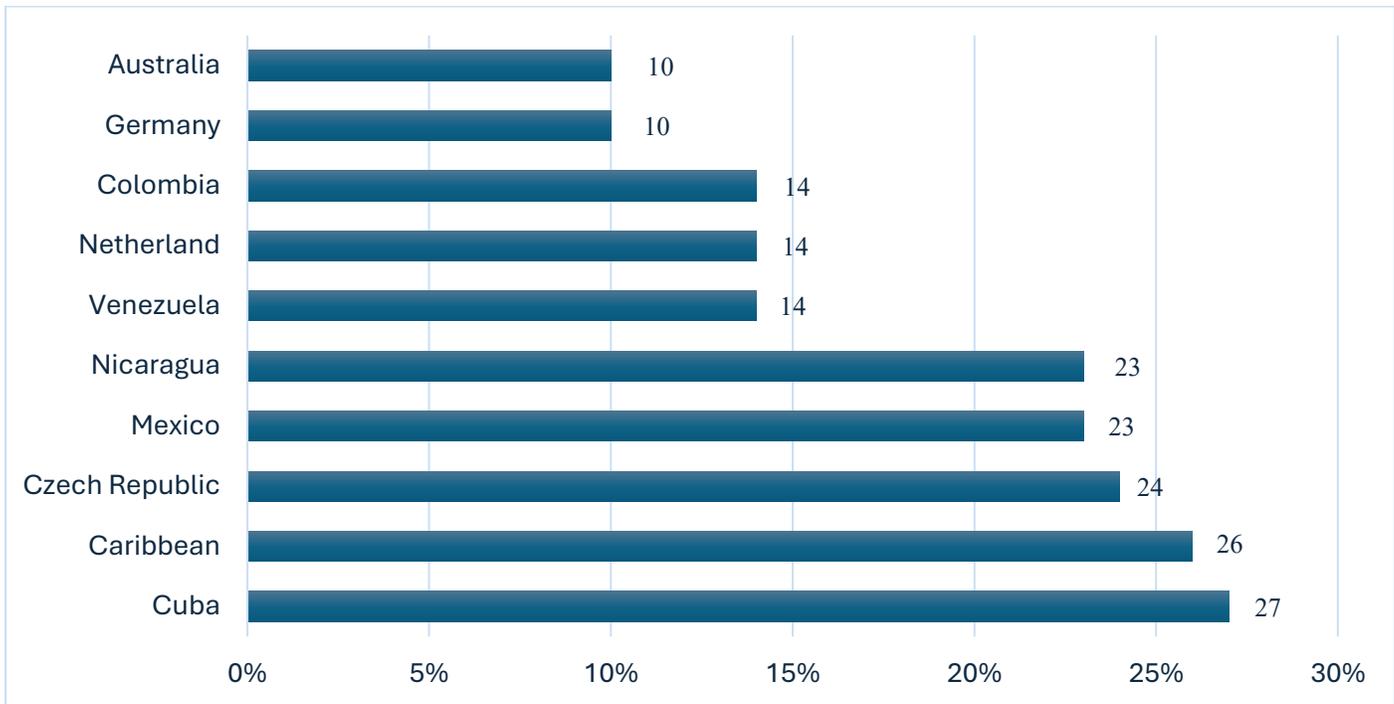
created questionnaire, distributed with IAP support, yielded 53 responses, which were reduced to 50 after removing duplicate submissions; respondents represented academies across IAP’s nine world regions and three global academies.

To ensure validity, the survey clearly defined what qualified as a “member” and applied a standard reference year (2013/2014) for all data. Disciplinary groupings from the IANAS survey were aligned with those in the ASSAf survey to allow consistent comparison. Reliability was strengthened using standard definitions, uniform data categories, and guidance from IANAS gender focal points to help respondents complete the questionnaire accurately. A 63% response rate further supports the robustness of the dataset. More details on the survey methodology are found in Ngila et al.<sup>2</sup>. This dataset was selected for its broad international coverage, standardized collection procedures, and direct relevance to examining women’s representation and participation in STEM-related governance structures in Africa. The study used data from a survey of IAP<sup>2</sup> members to visualize the share of women globally and in Africa (Figures 1 and 2).



Source: compiled by the author using the data from a survey of the members of IAP, (Ngila)<sup>2</sup>

**Figure 1.** Percentage of women share in surveyed national academy (N=63), by African countries



Source: compiled by the author using the data from a survey of the members of IAP, (Ngila)<sup>2</sup>

**Figure 2.** Percentage of women share in surveyed national academy (N=63), by global countries

The study also drew on World Bank data (2015-2017) on the female share of graduates from STEM programs. Descriptive statistics were calculated to summarize cross-country variation in STEM participation. The average share of women in STEM across the sample was 32%. Countries were classified into high-STEM (STEM > 32) and low-STEM (STEM < 32) groups based on this threshold. An independent-sample *t*-test compared GDP per capita growth between groups, and regression analysis assessed the relationship between STEM participation and GDP per capita growth.

## THEORETICAL FRAMEWORK

### STEM gender gap theories

The theoretical and conceptual framework explains gender gaps in STEM in Africa by drawing on Social Role Theory<sup>6</sup> and Gender Schema Theory<sup>7</sup> to show how societal expectations, stereotypes, and institutional norms shape women's educational and professional trajectories in science and technology. At the same time, socio-cultural factors, such as traditional gender roles and structural barriers in education, both

constrain women's participation and reveal pathways for empowerment and inclusion within STEM fields<sup>8</sup>.

### Theory of Gendered Socialization

Gendered socialization shapes educational and career outcomes by instilling socially constructed expectations about appropriate behaviours, abilities, and interests for boys and girls from an early age. Persistent stereotypes, particularly beliefs about girls' lower aptitude in mathematics, contribute to women's underrepresentation in STEM, as many exit the pipeline before entering professional fields due to cumulative societal messages and a lack of belonging<sup>9</sup>. These stereotypes are often unintentionally reinforced by parents and teachers, whose expectations and interactions can undermine girls' confidence and sustained interest in STEM subjects<sup>10</sup>.

Family environments further influence gendered pathways, as parental beliefs, choices of toys, and encouragement of specific activities shape children's self-perceptions and aspirations. Eccles<sup>11</sup> demonstrates that gender-based assumptions within

households can channel girls away from science and technology, reinforcing a cycle of exclusion that limits women's participation, advancement, and recognition in STEM education and the workforce<sup>12</sup>.

### Theory of Peer Groups

Peer influence during adolescence plays a decisive role in shaping students' academic choices, including engagement with STEM subjects, as course selection is often aligned with the achievements and priorities of close friends, particularly toward the end of high school<sup>13</sup>. For girls, peer approval and a sense of belonging are especially influential: supportive peer environments increase motivation, confidence, and willingness to enrol in mathematics and science, whereas peer groups that devalue STEM can discourage participation despite individual ability or interest<sup>14</sup>.

Research shows that adolescents are highly responsive to peer feedback, with encouragement strengthening confidence and engagement and negative or indifferent responses contributing to withdrawal<sup>15</sup>. In male-dominated STEM settings, the absence of visible peer support can reinforce perceptions that these fields are "not for girls," reducing enrolment and perpetuating gender imbalance. Conversely, peer encouragement has been shown to sustain girls' motivation and persistence in math and science, highlighting the importance of peer networks in either reinforcing or disrupting gendered pathways in STEM<sup>16</sup>.

### Theory of Stereotypes of STEM Professionals and Integrative Framework

Stereotypes surrounding STEM professions play a critical role in shaping women's participation by influencing how these careers are perceived and who is seen as belonging within them. Research by Cheryan et al.<sup>17</sup> shows that many STEM fields, particularly computer science and information technology, are culturally framed as male-dominated, socially isolating, and aligned with notions of innate brilliance, narratives that tend to alienate girls who are socialized to value collaboration and social connection. Media representations further reinforce these stereotypes by portraying STEM professionals in ways that rarely resonate with young women, narrowing their perceived fit with scientific careers (Steinke<sup>18</sup>).

Together, these dynamics sustain implicit biases that discourage women from entering and remaining in STEM fields. Addressing them requires challenging dominant cultural narratives through visible role models, mentorship, and efforts to dismantle stereotypes that undermine women's confidence and sense of belonging<sup>19</sup>.

Conceptually, the study is anchored in Social Role Theory<sup>6</sup> and Gender Schema Theory<sup>7</sup>, which explain how gendered expectations and cognitive schemas shape participation in STEM. These frameworks are operationalized through three complementary mechanisms: the Theory of Gendered Socialization, emphasizing the role of families and schools; the Theory of Peer Groups, capturing the influence of social networks; and the Theory of Stereotypes, explaining how cultural narratives and implicit biases sustain exclusion. Together, these perspectives provide an integrated lens for understanding persistent gender gaps in STEM across African contexts.

## RESULTS

The literature reveals persistent global and regional gender disparities in STEM participation, with women comprising only 29% of researchers worldwide and facing the lowest representation in low-income regions<sup>20</sup>. Marked regional variation exists: Sub-Saharan Africa (31.3%) and South and West Asia (18.5%) lag significantly behind Latin America and the Caribbean (45.4%) and Central Asia (48.1%). Within Africa, countries such as South Africa (43.7%) and Egypt (42.8%) approach global averages, while others, including Nigeria, Rwanda, and Cameroon, remain substantially underrepresented<sup>20</sup>.

Explanatory debates contrasting biological and sociocultural determinants largely discount biological determinism, as evidence shows that girls' scientific performance equals or surpasses that of boys in many contexts. This underscores the primacy of cultural, psychological, and institutional influences in shaping participation patterns<sup>20</sup>. One key psychological mechanism is stereotype threat, defined as the fear of confirming negative group stereotypes, which has been

shown to reduce performance, motivation, and persistence among women in STEM<sup>21</sup>.

Structural and cultural barriers further reinforce exclusion. Sociological analyses highlight gender bias, limited mentorship, and a lack of visible role models as systemic constraints<sup>20</sup>. Bourdieu's concepts of habitus, field, and capital explain how educational institutions normalize male dominance in disciplines such as physics and engineering, making them appear culturally incongruent for women and contributing to their concentration in life sciences, where belonging is stronger<sup>22</sup>.

Emerging pathways for change emphasize evidence-based interventions. Quantitative methods enable measurement of disparities and evaluation of policy impacts, while pedagogical innovations, particularly the shift from STEM to STEAM, integrate creativity and inclusivity into science education. Arts-integrated approaches have been shown to strengthen science identity and engagement among girls, especially from marginalized groups, by broadening definitions of competence and participation<sup>20</sup>. Together, these findings highlight the need for coordinated institutional reform, inclusive pedagogy, and targeted policy action to address entrenched gender inequalities in STEM.

### **Selected African women in STEM: Overcoming challenges and achieving excellence**

Although African women's participation in STEM remains constrained by structural inequalities, cultural norms, and persistent stereotypes that limit educational and professional opportunities, thirty women from 18 African countries have distinguished themselves across a wide range of STEM disciplines, demonstrating resilience and scientific excellence. The study profiles one representative from each African region, North, East, West, Central, and Southern Africa, to showcase diverse pathways to success.

#### **Adeyinka Falusi: Advancing medical research and mentorship**

Adeyinka Falusi, a retired professor of haematology at the University of Ibadan and President of the Sickle Cell Hope Alive Foundation (SChAF), has made significant contributions to medical research, particularly on genetic disorders such as sickle cell disease, with over

80 journal articles and 100 conference papers<sup>1</sup>. Overcoming early educational and infrastructural challenges in Nigeria, she advanced through perseverance, family support, and international research collaborations, securing major grants and building a distinguished academic career. Committed to mentorship, she has supported and inspired generations of female scientists through direct supervision, awards, and advocacy, emphasizing the critical role of visible role models in encouraging girls to pursue and succeed in science<sup>1</sup>.

Professor Adeyinka Falusi's trajectory reflects how women in STEM navigate culturally prescribed expectations explained by Social Role Theory<sup>6</sup> and Gender Schema Theory<sup>7</sup>, while overcoming structural constraints shaped through processes of gendered socialization<sup>12</sup>. Her experience demonstrates how mentorship and role modelling, supported by peer dynamics, can disrupt stereotypes, strengthen belonging, and create inclusive pathways for future generations of women in STEM<sup>16</sup>.

#### **Marian Ewurama Addy a biochemist from Ghana**

Marian Ewurama Addy a biochemist from Ghana was the first Ghanaian woman to become a full professor of natural science. conducted research in the biochemistry of herbal medicine and contributed significantly to science education and outreach in Ghana. She also served as the first Host of the national "Science and Maths Quiz," helping popularize science among young people<sup>23</sup>.

#### **Francine Ntoumi a Congolese molecular biologist**

Francine Ntoumi a Congolese molecular biologist, born in 1961 in Brazzaville is one of Africa's leading molecular biologists and infectious disease specialists, widely recognized for her groundbreaking research on malaria. Born in Brazzaville, she became the first African woman to earn a PhD in molecular parasitology from Paris-Sud University. She has held senior scientific positions with the World Health Organization and the European & Developing Countries Clinical Trials Partnership. As the founder and executive director of the CANTAM research network, she has built scientific capacity across Central Africa, mentoring a generation of women scientists and leading multi-country research on malaria, TB, and HIV/AIDS. She was the first

African to serve as secretariat coordinator of the Multilateral Initiative on Malaria (MIM) between 2007 and 2010. Her work has been recognized with major awards, e.g., the African Union Kwame Nkrumah Regional Scientific Award for Women (2012), and the Georg Forster Prize (Germany, 2015)<sup>24</sup>.

### **Akissa Bahri: Leading innovations in water and agricultural research**

Akissa Bahri, a professor at the National Agricultural Institute of Tunisia, has had an illustrious career in water and agricultural research. Selected as one of the few students to study in France, she attended Lycée Hoche in Versailles before earning an agricultural engineering degree from École Nationale Supérieure Agronomie de Toulouse in 1974. She later obtained a Doctorate in Engineering Science and Technology from the National Polytechnic Institute of Toulouse (1982) and a PhD in Water Resources Engineering from Lund University, Sweden (1995).

Growing up in a scientifically inclined, upper-middle-class Tunisian family, she was encouraged to pursue education equally with her brothers. As one of only two women among ten researchers in her institute, she had to prove herself in the male-dominated fields of agriculture and water management. Her research in the Kairouan Valley of Tunisia explored water scarcity and salinity challenges, analyzing interactions between soil, water, plants, and local farming practices. This work earned her the Grand Prize of Scientific Merit for Development from the Guinness Foundation in 1984. Committed to sustainable solutions, she pioneered research into solar-powered water pumps to reduce reliance on fossil fuels, collaborating on a renewable energy project with NASA and the Tunisian Electricity and Gas Company. Additionally, her groundbreaking research on the agricultural use of reclaimed water and sewage sludge addressed environmental concerns and sustainable resource management. Throughout her career, Akissa has remained dedicated to advancing science and advocating for women's leadership in STEM fields<sup>1</sup>.

Professor Akissa Bahri's career demonstrates how supportive upbringing, and equal educational opportunities counteract barriers described in Social

Role Theory and Gender Schema Theory, enabling her to pursue science alongside her brothers. Yet, as one of only two women.

### **Gladness George Mwanga: Bridging ICT and Agriculture for Rural Development**

Gladness George Mwanga, a research assistant and PhD candidate at the Nelson Mandela African Institution of Science and Technology, is passionate about using ICT to transform agriculture. Inspired by her parents and a dedicated math teacher, she excelled in science from a young age. Her innovative work in linking veterinary services with farmers through mobile and web applications earned her the 2014 UN FAO Young Innovators' Award, standing out among 15 African entries. During her master's degree, she developed a Livestock Information Management System, allowing farmers, extension officers, and researchers to exchange vital information efficiently, improving decision-making and productivity. Currently, the system operates as a prototype, with plans for expansion. Gladness believes that technology can bridge information gaps in agriculture, empowering farmers with real-time access to critical resources. Passionate about making a difference in Africa, she sees herself as a catalyst for change and is committed to exploring ICT solutions to improve lives.

Inspired by Rhoda Peace Tumusiime, the African Union's Commissioner for Rural Economy and Agriculture, she encourages young women to pursue science boldly, believing that the gender gap is more about societal pressures than actual ability. She advocates for mentorship, teacher training, and national science clubs to inspire more girls to embrace science careers<sup>1</sup>.

Gladness George Mwanga's path illustrates how early encouragement from family and teachers counters the cultural expectations described by Social Role Theory and Gender Schema Theory, helping her thrive in science. Her innovation in ICT for agriculture highlights how women can challenge stereotypes and expand into male-dominated fields, resonating with the Theory of Stereotypes. Inspired by role models like Rhoda Peace Tumusiime and committed to mentorship and science clubs, her story reflects the importance of peer groups and socialization mechanisms in

breaking barriers and encouraging more girls to pursue STEM.

### **Professor Widad Ibrahim Elmahboub a distinguished astrophysicist**

The Sudanese Professor Widad El Mahboub is a distinguished astrophysicist and scientist who has made significant contributions to her field. She earned her undergraduate degrees in applied mathematics and astrophysics in Sudan and Egypt before obtaining a master's degree in engineering physics from the University of Wisconsin-Madison. She later completed a doctorate in astrophysical engineering.

Prof. El Mahboub began her academic career as a professor of astrophysics and remote sensing systems at Hampton University. She then transitioned to NASA, where her research focused on analysing planetary components and enhancing the accuracy of satellite-based remote sensing imagery. Her groundbreaking-work led to the development of a highly precise computer-simulated mathematical model, followed by the implementation of an advanced algorithm and atmospheric correction method. This innovation significantly improved the accuracy and refinement of satellite imagery of Mars' surface.

In addition to her research, she has authored, co-authored, and edited numerous articles in scientific journals and periodicals, covering remote sensing, spectroscopy, and mathematical modelling. Her contributions have greatly advanced the field of astrophysics and remote sensing<sup>25</sup>.

Professor Widad Elmahboub's achievements in astrophysics highlight the persistence of women excelling in fields traditionally shaped by Gender Schema Theory and Social Role Theory, where cultural expectations often limit female representation. Her rise from Sudan to NASA underscores how individual determination and access to global academic opportunities can counter barriers emphasized by the Theory of Gendered Socialization. By excelling in highly technical, male-dominated domains, her work also challenges the biases described in the Theory of

Stereotypes, serving as a role model who redefines possibilities for women in science.

### **Quantitative results**

Figure 1 shows that women's representation in African national academies remains very low overall, with most countries reporting less than 12% membership. Tanzania (4%), Ethiopia (5%), and Sudan (5%) have the lowest shares, while South Africa (24%) stands out with the highest proportion, more than double that of other surveyed countries. These findings underscore the persistent gender gap in scientific leadership across the continent, with only limited progress in inclusivity.

Across the surveyed global countries, women's participation in national academies remains generally low, with most cases well below 30%. However, countries like Cuba and the Caribbean region stand out with the highest shares (26–27%), while Australia and Germany lag at just 10%. These findings highlight persistent gender disparities in scientific leadership worldwide but also point to regions that have made comparatively stronger progress in inclusion (Figure 2).

Together, Figures 1 and 2 show that while women remain underrepresented in national academies worldwide, the extent of the gap is more severe in Africa, where most countries are below 12%. By contrast, some global regions have achieved 20–27% inclusion, pointing to structural differences in how gender inclusivity is addressed.

The results of the Welch's two-sample t-test indicate a statistically significant difference in GDP per capita growth between countries with high and low STEM participation. Specifically, countries with STEM representation of 32% or higher demonstrated substantially greater GDP per capita growth ( $M = 4092.91$ ) compared to those with less than 32% STEM participation ( $M = 831.40$ ),  $t(10) = 2.58$ ,  $p = .028$  Table 1. These findings suggest that higher levels of STEM engagement are positively associated with stronger economic performance, underscoring the importance of promoting STEM education and participation as a driver of national economic growth.

**Table 1.** Welch’s t-Test: Comparing GDP per Capita Growth Between STEM > 32 and STEM < 32

	STEM >32	STEM < 32
Mean	4092.91	831.40
Variance	17348343.9	293805.24
Observations	11	11
Hypothesized Mean Difference	0	
<b>Test result</b>	<b>Value</b>	
t -statistics	2.58	
P-value (two-tails)	0.028	
Critical value ( $\alpha = 0.05$ )	2.23	

Calculated by the authors using World Bank data, 2015-2017.

The results of the simple ordinary least squares (OLS) regression indicate that STEM participation is, a statistically significant predictor of GDP per capita growth. Specifically, the estimated coefficient for STEM is 104.9 (SE = 49.3,  $p = 0.0461$ ), suggesting that, on average, a one-unit increase in STEM participation is associated with an increase of approximately 105 units in GDP per capita growth, holding all else constant. The 95% confidence interval (2.0 to 207.7) excludes zero, reinforcing the robustness of this finding at the 5% significance level.

The constant term was not statistically significant ( $p = 0.5842$ ), implying that the model does not provide a meaningful estimate of GDP per capita growth when STEM equals zero. In terms of explanatory power, the model achieved an  $R^2$  of 0.18, indicating that STEM participation explains approximately 18% of the variation in GDP per capita growth across the 22 observations Table 2. While this reflects a moderate relationship, it also highlights that other factors beyond STEM likely play a substantial role in influencing economic performance.

**Table 2.** Simple Ordinary Least Squares Regression: STEM as a Predictor of GDP per Capita Growth

Variable	Coefficients	Standard error	P-value	Confidence interval
Constant	-969.7	1743.4	0.5842	-4606.4 - 2666.9
STEM	104.9	49.3	0.0461	2.0 - 207.7

<b>Model statistics</b>	<b>Value</b>
F-statistic	4.52
Prob > F	0.046
$R^2$	0.18
Adjusted $R^2$	0.14
Observations	22

Calculated by the authors using World Bank data, 2015-2017

Overall, these findings provide empirical support for the hypothesis that higher STEM engagement is positively associated with greater GDP per capita growth. The quantitative results are consistent with the success stories drawn from the qualitative component of the study. All the featured women are researchers in different fields, such as medicine, agriculture, water resources, and solar energy, whose contributions support innovation and development, thereby reinforcing the link between women's STEM participation and economic growth. However, the relatively low  $R^2$  suggests that future research should incorporate additional economic, institutional, and social variables to develop a more comprehensive model of economic growth.

## DISCUSSION

### Summary of Key Findings

This study examined the relationship between women's participation in STEM and economic development, as well as broader patterns of gender representation in scientific institutions. The analysis revealed several key insights. First, women remain underrepresented in research globally, with the gap most pronounced in Africa where women's membership in national academies is often below 12%, compared to 20–27% in some regions such as the Caribbean and Latin America. Second, the empirical analysis showed that countries with higher female participation in STEM ( $\geq 32\%$ ) experienced significantly greater GDP per capita growth than those with lower participation. The t-test results demonstrated a robust and statistically significant difference in economic performance, while regression analysis confirmed that STEM participation is a meaningful predictor of GDP per capita growth.

### Strengths and Limitations

The strength of this study lies in its integration of both sociological theory (e.g., stereotype threat, Bourdieu's concepts of habitus and capital) and quantitative analysis (t-tests and regression models). This mixed approach provides a holistic perspective that connects cultural and institutional barriers with measurable economic outcomes. However, limitations include a relatively small sample size (22 observations) and the regression model's modest explanatory power ( $R^2 = 0.18$ ). This suggests that while STEM is an important

factor, many other structural and institutional variables also shape economic growth.

### Comparison with Previous Studies

The findings align with earlier work by the African Academy of Sciences (2020), which highlighted the persistent underrepresentation of women in STEM due to cultural and institutional barriers. Similarly, Ngila et al.<sup>2</sup> demonstrated that women's inclusion in national academies remains limited, particularly in Africa. At the same time, the positive association between STEM participation and GDP per capita growth is consistent with global evidence showing that investment in science and innovation drives productivity and development<sup>4</sup>. This study contributes by providing empirical evidence specifically linking women's STEM participation to economic outcomes in African and global contexts.

### Interpretation of Findings

Taken together, the results suggest that the underrepresentation of women in STEM is not only an equity issue but also an economic constraint. The significant t-test and regression results indicate that increasing STEM participation, particularly by addressing structural and cultural barriers that exclude women, can have measurable benefits for national economies. While female participation in STEM accounts for only part of the variation in GDP growth, its positive effect underscores the potential gains from greater inclusivity in science and technology.

### Implications of Findings

These findings have important implications for policy and practice. Promoting gender inclusivity in STEM is not only a matter of equity but also a strategy for economic growth. Expanding girls' access to STEM education, addressing stereotype threat, and reforming institutional cultures that sustain inequality can broaden the talent pool driving innovation. Integrating the arts into STEM education (STEAM) may further enhance inclusivity by combining creative and analytical skills; here, STEAM is treated as a pedagogical extension that complements, rather than replaces, the STEM framework used in the empirical analysis. For governments and universities, the results highlight the need for targeted investments in STEM

infrastructure, mentorship, and leadership opportunities for women.

### Future Research

While this study provides valuable insights, it is limited by its reliance on secondary data, which constrains the depth of analysis and the generalizability of findings across Africa's diverse contexts. Gender gaps in STEM are dynamic, shaped by evolving cultural, social, and institutional factors. To address these complexities, future research should prioritize field-based studies that generate primary data, regional comparative analyses that capture contextual differences, and policy-focused evaluations that assess the effectiveness of interventions promoting women's participation in STEM. Such efforts would enhance understanding and inform evidence-based strategies to foster equity and inclusion in science and technology.

### CONCLUSION

This study demonstrates that higher STEM participation is significantly associated with stronger economic growth, and that women remain systematically excluded from full participation in STEM fields, particularly in Africa. By situating the statistical evidence within broader sociological frameworks, the study highlights how stereotypes, cultural norms, and institutional barriers perpetuate exclusion while also constraining development. The relatively low  $R^2$  indicates that STEM is one of several drivers of economic growth, suggesting future research should incorporate additional social, institutional, and macroeconomic factors. Nonetheless, the evidence supports a clear conclusion: enhancing women's participation in STEM is both a matter of equity and an essential strategy for advancing sustainable economic development.

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and the logical flow of ideas. All final revisions and interpretations were made by the authors.

### CONFLICT OF INTEREST

The authors declare that they have no conflict of interest regarding the publication of this manuscript.

### AUTHORS' CONTRIBUTIONS

The authors worked as a team; all authors designed the study. The authors drafted the manuscript. Both authors reviewed, edited, and approved the final.

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