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Gender Disparity in STEM Programs in Kenya: Case of Dedan Kimathi University of Technology

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Abstract: Gender disparity in Science, Technology, Engineering, and Mathematics (STEM) programmes is a global challenge affecting women's academic and professional possibilities. This paper examines gender disparity in Kenyan STEM programmes, focusing on Dedan Kimathi University of Technology (DeKUT). The research examines the prevalence, causes, and effects of gender discrepancies in STEM education at the undergraduate level and how these disparities emerge at DeKUT. The study involves document analysis and quantitative data analysis on student enrolment patterns from 2019 to 2023. Results show a disparity in female placement for STEM courses with the highest female representation for the period at 29% in 2022. The findings can inform policymakers, educators, and organizations to implement targeted interventions, such as promoting female STEM networks, offering education on gender bias, and developing gender policies to achieve gender equality in STEM programs.

Keywords: Gender Inequality, Gender Disparity, Gender Inclusivity, STEM programs, Higher education.

1. Introduction

Science, Technology, Engineering, and Mathematics (STEM) education gives people skills that make them more employable and ready to meet the current labour demand. STEM encompasses a diverse array of experiences that cultivate critical thinking in students and readies them as professionals capable of revolutionizing society through innovative and sustainable solutions [1]. The STEM approach to education fosters creativity and divergent thinking alongside fundamental disciplines. STEM education prepares the world for the future. STEM awareness promotes interest in a range of careers that directly transform the society.

Gender disparities within STEM fields have emerged as a worldwide concern, limiting the full participation of women in these critical domains [2]. Women remain underrepresented in STEM education and professions, raising questions about the causes and consequences of this imbalance [3]. In Kenya, there is still a notable gender gap in STEM education, despite advances made toward gender equality in certain academic fields such as the arts and social sciences [4]. While Kenya has achieved gender parity in primary education and narrowed the gender gap at secondary level, disparities intensify in higher education, with women underrepresented in scientific disciplines, where men make up the majority of students and academic staff [5]. There is gender discrepancy at both public and private universities, with a particularly noticeable difference in STEM fields [6].

Within Kenyan public universities, trends in the enrolment of female students in STEM fields from 2009 to 2013 revealed that less than 30% of STEM students are female [7].

Moreover, female enrolment is 30% lower in some public universities and 40% lower in private universities [8]. According to [7], only one third of female STEM students graduated from three sampled universities, primarily due to reduced enrolment in STEM fields. In this regard, Kenya's Education and Training Gender Policy [9] is one of several gender-related policies the government of Kenya has developed to address the issue of how to best promote gender equity in higher education. One of the goals of STEM initiatives is to encourage broader participation of women and minorities in the STEM workforce to bridge ethnic and gender gaps [11]. There is a need for the engagement and participation of learning institutions, policymakers, parents, students, and educators to continue technological and scientific progress.

DeKUT has been chosen as a case study to investigate gender inequality in STEM programs in Kenya for several compelling reasons. As a technological university, DeKUT is focused on science and technology education, making it a representative national institution for the examination of gender disparities within STEM fields. The demographic composition of the university provides insights that align with the broader population of students in public higher education institutions. The availability of data from DeKUT for the period from 2019 to 2023 facilitates a comprehensive analysis of student enrolment patterns, allowing for an in-depth examination of gender disparities at the undergraduate level. This ensures a comprehensive examination of trends over a specific timeframe.

The study focused on the undergraduate level, with the aim of addressing specific challenges at this crucial stage of education, where gender imbalances may have significant implications for future STEM professionals. By selecting DeKUT, the research aims to identify existing disparities and provide insights that can inform targeted interventions within the university, potentially serving as a model for addressing gender inequality in STEM programs across Kenyan higher education institutions. This study contributes to the global conversation on promoting gender equality in STEM programs and careers to inform policy and practice

The rest of this paper is structured as follows: Section 2 presents an overview of gender disparity in STEM programmes in Sub-Saharan Africa. Section 3 presents the methodology. Section 4 discusses the results, and Section 5 encapsulates the key insights and conclusions drawn from this research endeavour.

2. Related Works

The inclusion of girls and women in STEM education demands a careful consideration of their overall access to and involvement in education. This representation of women in STEM fields is crucial because it promotes diversity in the workforce, which fosters success, productivity, creativity, and innovation [12]. This will ensure full women participation in economic activities and general wellbeing of the society [13]. Although there has been a global improvement in educational opportunities for girls and young women, significant disparities continue to exist both among and within regions and countries. According to [14], the enrolment rate by female students across three levels of education (primary, secondary and undergraduate) has been on an upward trend globally. Despite the favourable global trend, there exist notable discrepancies amidst regions and nations. In comparison to the developed countries, there exists a huge gender disparity in higher education levels in Sub-Saharan Africa where girls' gross enrolment ratio is below 20%.

The disparity in male and female representation in the fields of STEM becomes increasingly evident during the secondary education level where subject selection commences [15]. The United Nations Educational, Scientific and Cultural Organization (UNESCO) [14] in their report affirm that only about 30% of female students in higher education worldwide pursue STEM-related courses. In terms of the global average, the ICT

sector has the lowest percentage (3%), followed by engineering, manufacturing, and construction (8%), and natural science, mathematics, and statistics (5%). Significant regional and country differences exist with developed countries having a high number of female students enrolled in STEM, whereas Sub-Saharan Africa has a lower proportion [16]. Moreover, female engagement in STEM education and employment is not just low, but attrition is notably high. Women abandon STEM areas in disproportionate numbers during their education, transfer to the workplace, and even throughout their career cycle. This low female participation in STEM fields limits women's access to and use of productivity enhancing technologies, which in turn impacts SDG number three: well-being and excellent health [7, 11].

A study in Nigeria at Federal University Gusau revealed a significant increase in female student enrolment from 23% in the academic year 2014-2015 to 31.4% in the academic year 2019-2020, though this is still below the gender parity [17]. Another study by Tandrayen-Ragoobur et al in Mauritius discovered a gender disparity in STEM-related tertiary degree enrolment, with female students being less likely to pursue such degrees. [18]. A study in Ghana revealed a significant increase in female student enrolment from 27.4% in the academic year 2013-2014 to 33.0% in the academic year 2019-2020, however, this is still below the global average female enrolment of 35% as of 2015 [19].

Chauke [20] reports that less than 28.5% of female students graduate with careers in STEM education in South Africa, a worrying trend that highlights the gender gap in STEM education. The study by Appiah-Castel et al [21] found that from 2003 to 2018 there has been an increase in female students enrolled in STEM programmes at Kwame Nkrumah University of Science and Technology (KNUST), attributed to university intervention. However, from 2016 to 2018, the number of females admitted to STEM programs decreased, suggesting they may have enrolled in non-STEM programs. The disparity gap between qualified and admitted female students also decreased from 2014 to 2018, compared to 2003 to 2014. The college of sciences accounted for only 28.54%, engineering for 12.01%, and health sciences for 53.15% of the total number applying for STEM courses. Despite increased awareness of the need to address the gender-based gap, female students' access to higher education has not significantly improved. From 2015 to 2018, enrolment by gender type in STEM programs showed a rising gender disparity, with male enrolment increasing and female enrolment decreasing.

Kenya experiences gender disparities in higher education enrolment, particularly in advanced degree programs and scientific fields, such as mathematics and technical disciplines. In a study undertaken in Nairobi County, it was noted that boys tend to qualify for enrolment in science-based courses, while girls are more inclined towards arts-based courses [22]. This disparity can have far-reaching implications, leading to missed opportunities in STEM fields and a shortage of skilled manpower in the country. For many years, continuous financial contributions from charitable organizations, non-governmental organizations, governmental bodies, and various other entities have provided backing for endeavours aimed at increasing female participation in STEM fields [23]. Despite significant endeavours aimed at enhancing recruitment, retention, and progression, many STEM fields continue to experience minimal progress in terms of gender representation. Arguments on biological differences as causes of gender gap have been dismissed and evidence from different scholars affirms the existence of diverse factors contributing to the under-representation of women in STEM.

Mukhwana et al [24] states that 74% of university students study business, education, arts, and humanities. This leaves only 26% of students in STEM fields. Chavatzia et al [14] noted that female students account for only 35% of all students enrolled in STEM-related fields of study at higher learning levels. Engineering, manufacturing and construction, natural science, mathematics and statistics, and information and communication technology

have the lowest female enrolment. Conversely, there are considerable regional and national disparities in female representation in STEM subjects, indicating that contextual factors influence girls' and women's engagement in these professions.

According to the European Commission's 2018 report, there is a rising gender gap in digital engagement [25]. Bridging the digital gender gap in STEM is more than simply an issue of social justice; it goes beyond giving equal access for men and women. STEM courses are vital drivers needed to expedite the fulfilment of Kenya's vision 2030 and the United Nations' Sustainable Development Goals. Moreover, Kenya's vision 2030 regards gender inequality as one of the significant development barriers confronting the country. Consequently, to meet the established objectives, huge investments should be made in STEM programs to address the inherent gender disparity. Furthermore, the persistent low involvement of women in STEM means that the benefits that are likely to accrue from increased female engagement such as higher production and socioeconomic growth, may be difficult to attain.

UNESCO addressed the gender gap in STEM education by launching the STEM Mentorship Programme through Scientific Camps of Excellence in Kenya in 2014, targeting secondary school girls. The program aims to inspire girls to pursue science subjects and increase their involvement in STEM courses and careers. It offers a one-week intensive mentorship program primarily for average-performing students from rural areas. UNESCO also recognized the importance of training science teachers in gender-responsive pedagogy to sustain interest in STEM among students. The program uniquely incorporates mentorship talks by STEM role models, exposure to higher education institutions, and partnerships with the private sector to provide real-world examples of STEM applications. As of 2019, the programme had been implemented in 41 counties, with 161 schools reached and over 2,000 secondary school girls mentored [26].

According to [27, 28], several factors contribute to the under-representation of women and minority students in STEM fields, which include: stereotypes and bias, lack of visible role models, educational inequities, and cultural factors. Stereotypes and bias can limit opportunities for these students, while lack of visible role models can make them feel isolated. Educational inequities can limit opportunities for students from lower-income backgrounds, while cultural factors can impact aspirations and motivations. Addressing these factors requires a multifaceted approach that includes promoting diversity and inclusivity in STEM fields, increasing access to quality education and resources, providing visible role models, and creating inclusive workplace cultures. Collaboration among stakeholders, including academia, industry, policymakers, and communities, is crucial to create a more inclusive STEM environment.

3. Methodology

3.1 Problem Statement

Globally, notable advancements have been observed in the realm of education and the labour force. However, the rate of improvement has been uneven, with STEM fields still displaying a significant gender imbalance favouring males [5]. In Kenya, STEM provides tremendous advantages to the economy, but these benefits may not be completely realized due to lack of gender inclusivity in STEM programs [29]. STEM students are underrepresented in higher education, particularly among female students. Student enrolment in STEM courses within universities continue to face low female enrolments [6]. Additionally, as these females climb the academic ladder, their numbers reduce even further [30]. The bar established does not match the needed level for science-related courses, resulting in a shortage of STEM students in universities and, subsequently, in the labour market. When all of these statistics are combined, they demonstrate that female students are

in the minority in Kenyan institutions, particularly in STEM fields. Gender concerns are multifaceted, particularly in STEM, and have received little attention. The under-representation of women in STEM hinder realization of the United Nations Sustainable Development Goals like eradicating hunger and poverty [11].

The primary research objectives were to examine the gender distribution in STEM programs at DeKUT through a statistical representation of STEM courses uptake by female students in comparison to male and the extent to which gender in/equality has been accommodated in DeKUT. The statistical analysis also sought to determine how gender disparity has influenced placement of students in STEM programs at DeKUT. This study employed quantitative techniques through statistical analysis, which involved defining research objectives, pre-processing data, analysing descriptive statistics, conducting trend analysis, evaluating robustness, and interpreting results as shown in Figure 1.

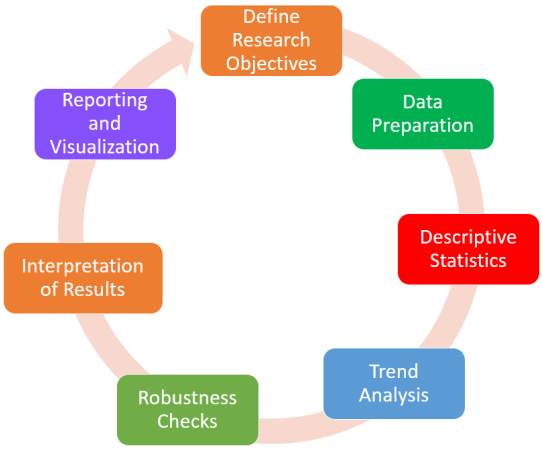

Figure 1 Conceptual framework depicting the methodology steps.

3.2 Data Collection and Analysis

The study was conducted using university placement data for 2015 from Kenya Universities and Colleges Central Placement Service (KUCCPS). Additional DeKUT student placement data for a period of 5 years from 2019 to 2023 from KUCCPS was analysed. The period was chosen because of the availability of complete data and because it would reveal the most recent trends in gender disparity. DeKUT was chosen as a case study since it is a technological public university in Kenya. The data provided background and contextual information pertaining to the students' uptake of STEM programs and female participation in STEM. To establish the trends in female uptake of STEM courses in DeKUT, KUCCPS data for the period 2019 to 2023 was analysed. The study focused on gender disparity in STEM and used visualizations to gain insights. Sensitivity analyses were conducted to assess the findings' suitability to different assumptions. The results were interpreted in the context of the research objectives and presented.

Table 1 shows the descriptive statistics for KUCCPS students' placement into DeKUT from 2019 -2023. The table presents gender ratio analysis of students with a glaring disparity of gender in the placement with male placement having a record of 50% higher than female students for the period.

	Year	Male	Female
1	2019	1233	601
2	2020	1319	647
3	2021	1303	641
4	2022	1126	590
5	2023	1154	509

Table 1 Students' placement at DeKUT for all courses from 2019-2023

4. Results

Statistical data analysis was done using python and presented using charts, tables and graphs. Quantitative data was analysed using descriptive statistics and trend analysis. The country-wide perspective on STEM gender disparity from KUCCPS placement data for 29 public universities for the year 2015 is shown in Table 2. The results show that a total of 36,495 students were placed in STEM courses with 23,058 (63.2%) male and 13,437 (36.8%) female. Science courses received the highest number of students (27,257) with 16,401 (60.2%) male and 10,856 (39.8%) female.

	Male	Female	% of male	% of female
Engineering	1871	521	78.2%	21.8%
Mathematics	2347	1133	67.4%	32.6%
Science	16401	10856	60.2%	39.8%
Technology	2439	927	72.5%	27.5%
Grand Total	**23058**	**13437**	**63.2%**	**36.8%**

Table 2 Student distribution in STEM courses by category for the year 2015

Gender-wise student distribution per STEM course category was performed by sampling data for top 5 universities with the highest student placement: Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenyatta University (KU), Technical University of Kenya (TU-K), University of Eldoret (UoE), University of Nairobi (UoN). The results were compared against DeKUT's placement data (summarized in Table 3).

	Gender	JKUAT	KU	TU-K	UoE	UoN	DeKUT
Engineering	Male	314	153	535	57	209	155
	Female	117	49	118	18	60	37
	% of female	27.1%	24.3%	18.1%	24.0%	22.3%	19.3%
Mathematics	Male	240	96	135	54	92	33
	Female	157	36	47	29	48	33
	% of female	39.5%	27.3%	25.8%	34.9%	34.3%	50.0%
Science	Male	976	1203	774	1221	1096	207
	Female	796	795	349	914	611	100
	% of female	44.9%	39.8%	31.1%	42.8%	35.8%	32.6%
Technology	Male	119	181	458	137	33	39
	Female	47	98	192	82	9	15
	% of female	28.3%	35.1%	29.5%	37.4%	21.4%	27.8%
Grand Total	% of male	59.6%	62.5%	72.9%	58.5%	66.3%	70.1%
	% of female	40.4%	37.5%	27.1%	41.5%	33.7%	29.9%
	TOTAL	**2766**	**2611**	**2608**	**2512**	**2158**	**619**

Table 3 Student distribution in STEM courses by category, gender and university for the year 2015

The results show that in Engineering courses JKUAT received the highest female placement of 27.1%. In Mathematics courses DeKUT had 50% with JKUAT having 44.9% in Science and UoE having 37.4% in Technology courses. Generally, in 2015 TU-K received the highest number of male students at 72.9% with UoE receiving the highest number of female students at 41.1%.

The enrolment rate of male and female students in STEM courses offered by DeKUT from the 2019–2023 academic year is shown in Table 4. The data indicates that over the five-year period under evaluation, there was a decrease in the overall enrolment of female

students in STEM courses compared to male students. Additionally, there were significant differences in the enrolment rates of female students in STEM courses among the various fields. Engineering courses received the highest placement during the period, but with the biggest gender disparity, where the highest female percentage was 25.3% in 2019. The enrolment trend in Science, Technology, and Mathematics programs showed an increase in female student enrolment from 2019 to 2022, in contrast to engineering programs, which showed a decrease in female enrolment during the same period. In 2023, the percentage of female students enrolled in science decreased to 27.9%, mathematics decreased to 38.1%, while engineering saw a decrease in female students enrolled to 22.9%.

	Gender	2019	2020	2021	2022	2023
Engineering	Male	442	462	478	396	501
	Female	150	138	137	129	149
	% of female	25.3%	23.0%	22.3%	24.6%	22.9%
Mathematics	Male	59	89	101	86	69
	Female	20	62	58	53	39
	% of female	25.3%	41.1%	36.5%	38.1%	36.1%
Science	Male	147	187	152	117	132
	Female	83	102	109	75	51
	% of female	36.1%	35.3%	41.8%	39.1%	27.9%
Technology	Male	321	328	320	315	312
	Female	114	99	111	116	124
	% of female	26.2%	23.2%	25.8%	26.9%	28.4%
Grand Total	% of male	72.5%	72.7%	71.7%	71.0%	73.6%
	% of female	27.5%	27.3%	28.3%	29.0%	26.4%
	TOTAL	**1336**	**1467**	**1466**	**1287**	**1377**

Table 4 Student distribution in STEM courses by category and gender for the year 2019-2023

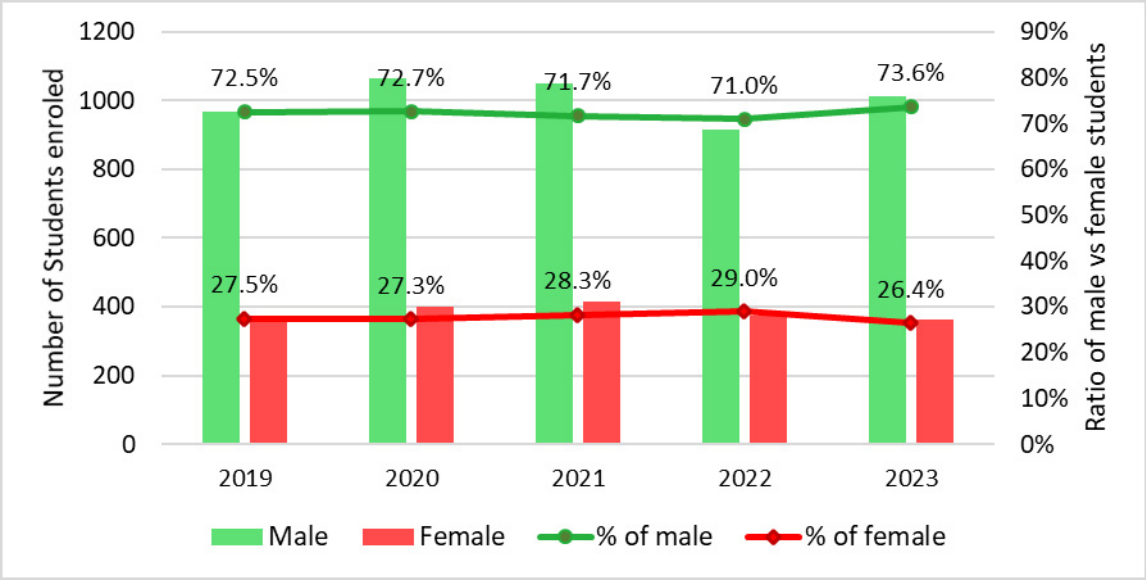

Figure 2 Percentage enrolment of students in STEM courses for the year 2019-2023

Overall, Figure 2 visually underscores a gradual and steady increase in the percentage of female students enrolled in STEM courses, from 27.5% in 2019 to 29.0% in 2022. However, this positive trajectory faced a setback in 2023, with the female enrolment dropping to 26.4%, while male enrolment experienced an increase to 73.6%. These findings underscore the urgency of addressing gender inequality in STEM programs at DeKUT. The identified disparities necessitate further exploration of underlying factors contributing to the observed trends. Future interventions should focus on creating a more inclusive and

equitable environment, promoting equal opportunities for both male and female students in STEM fields, and fostering initiatives to attract and retain female talent.

The findings of the current study align with and contribute to the existing body of literature on gender inclusivity in STEM education. Several key points of convergence and divergence emerged upon comparing the results of this study with the relevant literature. Consistent with prior research [31, 32], the current study highlights the persistence of gender disparities in STEM fields. Female students continue to face challenges related to access, representation, and stereotyping, indicating that despite ongoing efforts, certain systemic issues remain entrenched within STEM education. In line with the findings in [33], this study recognizes the nuanced challenges faced by female students across different STEM disciplines. Variations in experiences and barriers were identified, emphasizing the need for tailored interventions that consider the unique characteristics and demands of individual STEM fields. Expanding on the recommendations in [34, 35], the current study emphasizes the importance of adopting intersectional approaches to address gender disparities. Recognizing the intersectionality of gender with race, socioeconomic status, and other factors emerged as a critical consideration for developing comprehensive strategies that account for the diverse experiences of female students in STEM.

5. Conclusion

This study underscores the persistent gender disparity within STEM programs at Dedan Kimathi University of Technology (DeKUT), shedding light on the necessity for targeted interventions to foster gender inclusivity. Despite notable progress in certain years, setbacks observed in 2023 emphasize the fragility of advancements and the ongoing challenges faced by female students pursuing STEM education. The overarching conclusion is that gender equality in STEM remains an elusive goal, necessitating sustained efforts and multifaceted strategies for meaningful and lasting change. The quantitative analysis exposed a consistent gender gap in STEM enrollment at DeKUT, with the percentage of female students lingering below 30%. Engineering courses displayed the most significant gender disparity, with female representation consistently falling short of desired levels. The setback witnessed in 2023, where the percentage of female enrollment dropped to 26.4%, underscores the nuanced and dynamic nature of gender balance within STEM programs.

Several factors contribute to the observed gender disparity, including deeply ingrained societal stereotypes, limited availability of female role models in STEM fields, and cultural influences shaping career choices. These challenges create formidable barriers for female students aspiring to pursue STEM disciplines, affecting their confidence, opportunities, and overall academic and professional experiences. The study's findings hold broader implications for both the academic community and policymakers. The gender gap identified in STEM programs at DeKUT calls for urgent attention to create a more inclusive learning environment. The setbacks observed in 2023 highlight the need for continuous monitoring and proactive measures to counteract potential regressions in gender inclusivity efforts.

5.1 Recommendations

A crucial recommendation is to implement mentorship programs tailored for female students in STEM fields. These programs should establish structured mentorship systems, pairing students with accomplished women in STEM. Mentorship offers invaluable insights, encouragement, and a supportive environment, aiding female students in overcoming challenges, making academic and career decisions, and navigating male-dominated STEM settings. Regular mentor interactions empower students, fostering confidence and a sense of community within STEM disciplines. A critical aspect of promoting gender inclusivity in STEM education involves conducting targeted awareness campaigns. These campaigns should challenge stereotypes, dispel misconceptions, and

highlight the diverse and impactful contributions of women in STEM fields. Utilizing various communication channels, including social media, workshops, and seminars, can effectively reach students, educators, parents, and the broader community.

To address systemic barriers contributing to gender disparities, active advocacy for policy changes is essential. Collaboration with educational institutions, policymakers, and relevant stakeholders to review and amend existing policies that may inadvertently hinder gender inclusivity in STEM programs is crucial. This includes revisiting admission criteria, scholarship distribution, and faculty recruitment processes to ensure fairness and equal opportunities for all students. Recognizing the significant influence of communities on students' educational choices, it is crucial to engage with local communities in initiatives promoting gender equality in STEM. Work collaboratively with parents, teachers, and community leaders to challenge traditional gender roles and biases. Organize community events, workshops, and outreach programs that highlight the importance of equal opportunities in education and careers.

Within the university, establishing formal support networks and forums for female students in STEM should be considered. These networks can serve as platforms for peer support, knowledge sharing, and the exchange of experiences. Creating a sense of community within the institution can help female students overcome isolation, share resources, and navigate academic and career challenges collectively. To ensure the effectiveness of the recommended interventions, it is imperative to establish a monitoring and evaluation framework. Regularly assess enrollment data, academic performance, and feedback from female students to gauge the impact of implemented measures. Then use this data to make informed adjustments to strategies and interventions, ensuring that they remain responsive to the evolving needs and challenges faced by female students in STEM.

5.2 Future Research Directions

To deepen our understanding of the long-term impact of implemented interventions, future research should undertake a longitudinal study. Tracking the academic and career trajectories of female students who participated in mentorship programs, awareness campaigns, and other initiatives over an extended period will provide insights into the sustained influence of these interventions.

The scope of research can be extended by conducting a comparative analysis with other institutions, both regionally and globally. Comparing the effectiveness of interventions across diverse academic environments can reveal best practices, challenges specific to certain contexts, and innovative approaches that have yielded positive outcomes elsewhere. This broader perspective can inform the development of tailored strategies for promoting gender equality in STEM education, considering the unique characteristics and challenges of different institutions.

Researchers should consider incorporating an intersectional lens into future research endeavours. Explore how factors such as race, socioeconomic background, and cultural differences intersect with gender to influence the experiences of female students in STEM. An intersectional approach will provide a better understanding of the challenges faced by diverse groups of women and inform the development of targeted interventions that address multiple dimensions of disparity within the STEM educational landscape.

Embracing emerging technologies to enhance the accessibility and effectiveness of support mechanisms for female students is crucial. This can be achieved by developing and implementing digital platforms, mentoring apps, or virtual support networks that facilitate continuous communication, resource sharing, and mentorship opportunities. The integration of technology can overcome geographical constraints, ensuring that female students in remote areas have access to the same level of support as their counterparts in more centralized locations.

Recognizing the dynamic nature of educational landscapes and societal norms, future research should emphasize continuous assessment and adaptation of strategies. Regularly collect and analyse data on enrolment patterns, academic performance, and the experiences of female students to identify emerging challenges and opportunities.

In conclusion, this study serves as a crucial step toward unraveling the complex web of factors contributing to gender disparity in STEM programs at DeKUT. It is our hope that the recommendations put forth will inspire actionable steps, fostering a more inclusive and equitable educational landscape for future generations of aspiring STEM professionals. The journey towards gender equality in STEM is ongoing, and the collaborative efforts of academia, policymakers, and the wider community are essential to bring about meaningful change.

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