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A gender-based assessment of Science, Technology and Innovations in Higher Education Ecosystem in Malawi

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ABSTRACT
Malawi has a number of policies to promote gender equality and social inclusion and advocate for women participation in science, technology and innovations. Yet, participation of women and girls in science, technology and innovations is still low. The study examined the current status of science, technology and innovations in higher education in Malawi with a gender perspective. The review was conducted to assess the national commitment and strategies in promoting gender equality. The study also used 2021/2022 public universities' selection data and five-year (2017-2022) enrolment data from the National Council for Higher Education. The findings revealed commitment of Malawi in promoting science, technology and innovations and ensuring gender equality and inclusiveness in higher education through its policies and plans. However, despite an overall increase of 36% in enrolment of students in public universities from 2017 to 2022, enrolment of female students was still low with a highest enrolment rate of 42% in 2021/2022 academic year. The enrolment of female students in science, technology and innovation programmes was even lower with less than 20% female participation. In 2021/2022 academic year, only 35% of the STEM related programmes were among the 20 top popular programmes while 90% were among the 21 least popular programmes. The study recommends a holistic approach in addressing barriers to women and girls' participation in ST&I and higher education by targeting upper primary and secondary school students, parents/ guardians, and rural community leaders among other interventions.

Key words: Gender equality, Higher Education, Malawi, Social inclusion, STEM

RÉSUMÉ
Le Malawi a un certain nombre de politiques visant à promouvoir l'égalité des sexes et l'inclusion sociale et à plaider pour la participation des femmes à la science, à la technologie et aux innovations. Pourtant, la participation des femmes et des filles à la science, à la technologie et aux innovations est encore faible. L'étude a examiné l'état actuel de la science, de la technologie et des innovations dans l'enseignement supérieur au Malawi dans une perspective de genre. Une étude etait menée pour évaluer l'engagement et les stratégies nationales en matière de promotion de l'égalité des sexes. L'étude a également utilisé les données des universités publiques sélectionnées de 2021/2022 et les données d'inscription sur cinq ans (2017-2022) du Conseil national de l'enseignement supérieur. Les conclusions ont révélé l'engagement du Malawi à promouvoir la science, la technologie et les innovations et à garantir l'égalité des sexes et l'inclusion dans l'enseignement supérieur par le biais de ses politiques et plans. Cependant, malgré une augmentation globale de 36% des inscriptions d'étudiants dans les universités publiques de 2017 à 2022, les inscriptions d'étudiantes étaient encore faibles avec un taux d'inscription le plus élevé de 42% au cours de l'année académique 2021/2022. L'inscription des étudiantes dans les programmes de science, de technologie et d'innovation

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était encore plus faible avec moins de 20 % de participation féminine. Au cours de l'année académique 2021/2022, seuls 35 % des programmes liés aux STEM figuraient parmi les 20 programmes les plus populaires, tandis que 90 % figuraient parmi les 21 programmes les moins populaires. L'étude recommande une approche holistique pour éliminer les obstacles à la participation des femmes et des filles à la ST&I et à l'enseignement supérieur en ciblant, entre autres interventions, les élèves du deuxième cycle du primaire et du secondaire, les parents/tuteurs et les dirigeants des communautés rurales.

Mots clés: Égalité des genres, Enseignement supérieur, Malawi, Inclusion sociale, STEM

INTRODUCTION

The role of Science, Technology and Innovations (ST&I) in the social and economic development of any country cannot be overemphasized. The Malawi 2063 development agenda recognizes that science, technology and innovation is a catalyst for achieving its three pillars namely: Agriculture Productivity and Commercialization, Industrialization, and Urbanization (NPC, 2020). Hence, the emphasis on human capital development including strengthening infrastructure in ST&I such as construction of world-class laboratories and expanding programmes in Science Technology, Engineering, Arts and Mathematics (STEAM) as an enabler to achieve the vision. The higher education institutions and technical and vocational education training institutions in Malawi are challenged to expand opportunities to STEAM programmes for both male and female students. However, gender inequalities still exist in the enrolment and participation in Science, Technology, Engineering, and Mathematics (STEM) programmes, careers and higher education ecosystem. The barriers to access and success for female students in STEM are well documented world-wide, including in Malawi, and from numerous perspectives, leading to findings which suggest that: STEM environments can be unfriendly for women.

A study on gender and inclusivity in Malawi's technical institutions, classified programmes were as male-dominated and female-dominated depending on the nature of the programme ((UNESCO, 2018). Less than 40% of the female applicants were enrolled in technical programmes. The ratio of female to male students in Malawi's technical training colleges remains unbalanced with 30:70 for STEM related programmes and 70:30 for programmes such as secretarial studies, tailoring and design. Not surprisingly, female students identified the shortage of female lecturers as one of the barriers to their success in male-dominated STEM programmes. Other identified barriers related to lack of inclusive policies and strategies along with an absence of concrete and measurable actions and outcomes from policies and interventions. Some barriers are more fundamental and originate from culture and deficits in early education. The educational deficits greatly affect female students' ability to enroll in STEM programmes in higher education.

Nevertheless, globally, there have been interventions designed to increase women's participation and success such as: active, or inquiry-based, learning in STEM (Craig, 2014; Savage, 2018); engineering design (Chukwurah and Klein-Gardner, 2014); after-school gender equity mentorship programs (Froschl and Sprung, 2014); alternative pedagogies (Taube and Polnick, 2014); assessments in STEM courses (Wallace and Hattingh, 2014) and mentorship programmes/workshops for sustaining female STEM faculty in higher education institutions (Mavriplis *et al*., 2014). The reality is that well-intentioned interventions can unintentionally perpetuate equally (or more) harmful barriers to women's participation in STEM such as feelings of being tokenized (Garces and Jayakumar, 2014), stereotype threat (STT) (Steele and Aronson, 1995; Fink, 2015; Gregory, 2017), and misguided ('deficit') focus on fixing and fitting women into STEM instead of challenging underlying social

and cultural beliefs about the nature of STEM.

Despite the initiatives to increase women participation in STEM, women still lag behind in enrolment in STEM fields. However, there is inadequate information on gender assessment in ST&I and higher education ecosystem to ascertain the effectiveness of the initiatives in reducing the gender gap in ST&I and higher education. This paper presents findings from the gender assessment in ST&I and higher education ecosystem in Malawi.

METHODOLOGY

Data were collected through document analysis of policies, legislatures and other reports that promote the advancement of science, technology and innovations as well as supporting gender equality in ST&I. A number of documents were analysed and these included: The Malawi 2063; the National Science and Technology Policy and the Science and Technology Act (2003), The National Commission for Science and Technology (NCST); the National Education Sector and Investment Plan (NESIP 2020-2030); The National Inclusive Education Strategy (NIES-2017-2021); and The model gender and anti-sexual harassment policy for higher education institutions in Malawi. The analysis was conducted to assess Malawi's commitment in promoting Science, Technology and Innovations and ensuring gender equality and inclusiveness in higher education especially in STEM programmes.

The study used five-year (2017-2022) enrolment data from the National Council for Higher Education (NCHE) to assess participation of female and male students in STEM related programmes. The study mainly focused on the six public universities namely: University of Malawi (UNIMA), Mzuzu University (MZUNI), Lilongwe University of Agriculture and Natural Resources (LUANAR), Malawi University of Science and Technology (MUST), Kamuzu University of Health Sciences (KUHeS) and Malawi University of Business Sciences(MUBAS). Most of the STEM related programmes in Malawi are offered by public universities. The STEM programmes were selected based on the significant differences in enrolment rates between male and female students. Programmes with large gender disparities were selected. The time series data provided trends on the enrolment of female students in ST&I programmes over the five years. The study also used the 2022 public universities' selection data from the National Council for Higher Education (NCHE). The selection data were used to assess students' choices in relation to science, technology and innovations' programmes.

FINDINGS AND DISCUSSION

Gender Equality and Social Inclusion in ST&I: Overview of policies and legislature. There are a number of policy documents that support the Malawi's STI systems and gender equality in STI and higher education. These include: The Malawi 2063; the National Education Sector and Investment Plan (NESIP 2020-2030); The National Inclusive Education Strategy (NIES-2017-2021); The model gender and anti-sexual harassment policy for higher education institutions in Malawi; and the National Science and Technology Policy and the Science and Technology Act (2003).

The Malawi 2063 expresses the vision of the country to be an inclusively wealthy and self-reliant nation through its three pillars namely: 1. agriculture productivity and commercialization; 2. Industrialization, and 3. Urbanisation. It recognizes the role of science, technology and innovations in achieving this vision and calls upon institutions of higher education to strengthen infrastructure in STIs and expand programmes in STEM in order to increase human capacity required to implement the pillars. The Malawi 2063 also calls for inclusiveness in wealth creation by ensuring gender equality in all activities including participation in ST&I and higher education. The vision, therefore, provides opportunities for higher education ecosystem to be creative and innovative in strengthening ST&I and increasing participation of women in ST&I and higher education (NAP, 2020).

The National Science and Technology Policy. The policy recognises the role of science and technology in enhancing socio-economic development of the country and improving the standard and quality of life of Malawians. This will be achieved through: (i) Establishing and strengthening national capacity for research; (ii) Developing and raising the national productive capacity and improve competitiveness through the efficient application of technologies; (iii) Promoting and developing traditional, endogenous, new and innovative technologies; and (iv) Creating knowledge and S&T awareness to improve and develop the scientific and technological culture of Malawians. The policy also provides for an elaborate organisational structure (Figure 1) to institutionalise ST&I in Malawi. The structure includes the cabinet committee on science and technology whose role is to scrutinise draft policies and bills before they are presented to the full cabinet. The structure also includes the Parliamentary Committee on Education, Science and Human Resources that performs an advisory role to the National Assembly on science and technology matters (Figure 1). The draft policies and bills related to science and technology are referred to this Committee prior to being debated in the National Assembly. The existence of these committees shows the national commitment and political will towards ST&Is and presents a challenge for higher education to respond to the increasing demand for ST&Is.

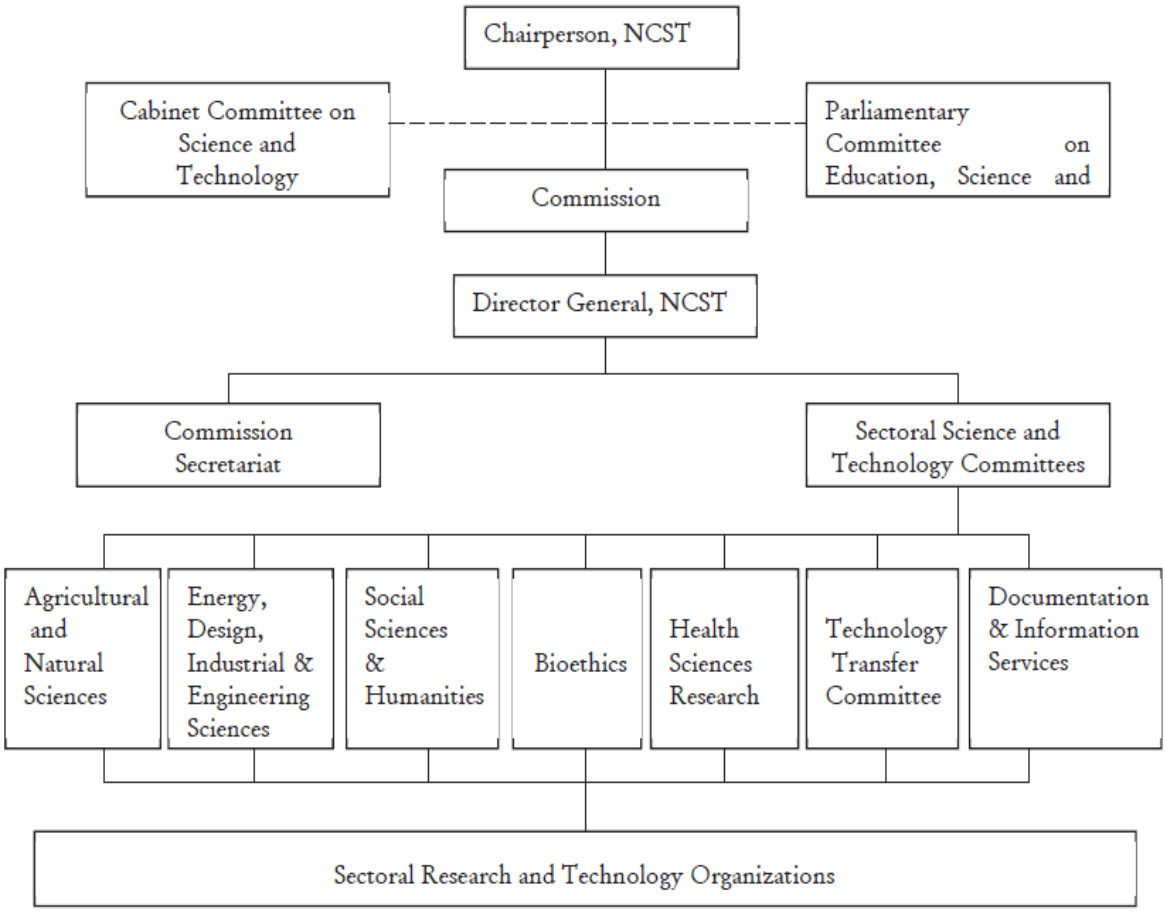

Figure 1. Institutional and Organization Framework for STI in Malawi

The policy also proposes adopting strategies that foster the participation of women in the development and utilization of S&T that include: (i) encourage research into all forms of gender differentiation in S&T education and employment; (ii) promote women's access to S&T education at all levels; (iii) foster gender equity in S&T in education and the workplace; (iv) facilitate the entry of women into employment in S&T fields and their career advancement, and; (v) foster socially responsible, gender-inclusive S&T. However, despite these strategies that have been there over the years, women are still underrepresented in higher education especially in ST&I programmes. This calls for further assessment whether the strategies were implemented or there were challenges that affected their implementation.

The Science and Technology Act (2003). This is the legislature that provides a legal backing for the advancement of science and technology in Malawi. The main objectives of the Act were to: (i) Provide for the advancement of science and technology; and (ii) Establish the National Commission for Science and Technology. The Act became operational in 2008 and the National Commission of Science and Technology in Malawi was established in 2009 through this Act.

The National Commission for Science and Technology. The Commission was established as a principal advisory body to Government and other stakeholders on all science and technology matters for advancement of science, technology and innovation for sustainable growth and development in Malawi that will also lead to wealth creation as well as improving quality of life for all Malawians. The commission reports to the Ministry of Education, Science and Technology on policy and technical issues and the Department of Statutory Corporations in the Office of the President and Cabinet on governance and other administrative matters. The Commission has seven functional sectoral committees namely: (i) Agriculture and Natural Sciences, (ii) Energy, Design, Industrial and Engineering Sciences, (iii) Social Sciences and Humanities, (iv) Bioethics; (v) Health Sciences Research, (vi) Technology Transfer; and (vii) Documentation and Information Services. These committees are the entry points for the research institutions and higher education institutions to advance their agenda in science, technology and innovations. Recently, the commission in collaboration with the Directorate of Science and Technology in the Ministry of Education, Science and Technology is hosting the Women in Science Engineering and Technology Organisation (WSETO) in Malawi. This is a platform where women interact, share experience and network on ST&I issues. Currently the platform has 210 participants. The commission also provides a forum for disseminating research in science and technology through the annual dissemination conferences. The forum can be used to drive the agenda for promoting gender equality and social inclusion in science, technology and innovations.

The National Education Sector Investment Plan (NESIP- 2020-2030). The NESIP (2020-2030) is a long-term strategic document for the education sector that guides the implementation of key activities to achieve national and international commitments from 2020 to 2030. The plan emphasizes the need to increase access to education at all levels. For example, in the higher education sector, the Government committed resources to expand physical infrastructure at Malawi University of Science and Technology (MUST) and Lilongwe University of Agriculture and Natural Resources (LUANAR). In addition, the University of Malawi was delinked on 4th May, 2021 into three universities namely: Malawi University of Business and Applied Sciences (MUBAS), Kamuzu University of Health Sciences (KUHES) and University of Malawi (UNIMA) to further increase access to higher education and improve governance and management of the public universities. Besides establishment of new public universities, other innovative Open and Distance Learning (ODL) approaches in higher education are expected to

further increase access to higher education in Malawi. The plan also emphasizes on inclusive and equitable access to education. The strategies have been put in place to ensure that female and disadvantaged students including persons with disability have access to higher education. One of the strategies is ensure that all physical infrastructures such as classrooms, laboratories and hostels in higher education institutions are accessible by persons with disabilities.

The National Inclusive Education Strategy (NIES-2017-2021). Over the years, the Education Sector in Malawi has been facing challenges of equity, access, quality, relevance, governance and management. The strategy was developed to show commitment of the Government of Malawi in promoting equitable access to relevant and quality education at all levels, namely Early Childhood Development, Primary Education, Secondary Education, and Tertiary Education. It also responds to the UN conventions and agreements to which Malawi is party to. The NIES was a medium-term intervention aimed at promoting quality inclusive education at all education levels. This was also the basis for increasing access to higher education for female students and Persons With Disabilities (PWD). During the implementation period of this strategy, female enrolment in public universities increased from 33% in 2008 to 41% in 2018 as a result of Government's affirmative action though female enrolment in STEM programmes remains lower than that of their male counterparts.

Model Gender and Anti Sexual Harassment Policy for Higher Education Institutions (HEIs) in Malawi (2021). There are discrepancies in enrolment, performance as well as participation in decision making in HEIs in Malawi. To address this, NCHE with funding from United Nations Development Programme (UNDP) developed a model gender policy to create a gender-transformative environment in HEIs for all staff and students, particularly women and persons with disabilities. Among others, the policy promotes equality in the enrolment, retention and performance of male and female students as well as equal representation of male and female staff in recruitment and decision-making positions. The policy also provides for inclusive education where infrastructure and materials are supposed to be accessible by Persons with Disabilities. The HEIs are supposed to use this opportunity to close the gap between male and female students in science and technology programmes by ensuring that strategies are in place to increase enrolment, enhance performance and increase retention of students.

Current Status of Higher Education Institutions in Malawi. The universities in Malawi fall into two primary sub-sectors: public universities, which are established by Government through Acts of Parliament; and private universities, which are established through university charters but are accredited by Government. The Ministry of Education, Science and Technology is responsible for drafting bills to establish public universities but does not exercise direct control over public universities, as these are statutory organizations which are governed by the board of governance. However, the directorate of Higher Education within MoEST works closely with public universities and serves as a link between universities and the Government on matters of policy. Public universities in Malawi are subsidized by the Government and they obtain funding directly from the Ministry of Finance.

Currently, there are six public universities in Malawi namely: University of Malawi (UNIMA), Mzuzu University (MZUNI), Lilongwe University of Agriculture and Natural Resources (LUANAR), Malawi University of Science and Technology (MUST), Kamuzu University of Health Sciences (KUHeS) and Malawi University of Business Sciences (MUBAS). The LUANAR was delinked from UNIMA in 2012 while MUBAS and KUHeS were delinked in 2021. All the six public universities were established by Acts of Parliament which clearly delineate institutional governance and management structures. The delinking of UNIMA is an opportunity for increasing access to higher education. The 2021/22 enrolment

registered an increase of 6% from the 2020/2021 enrolment. This was unexpected very low increase rate considering that two new universities were established. The Government of Malawi is further investing in physical infrastructure such as laboratories, lecture theatres and hostels to allow more students to enrol in public universities.

There are 21 Private Universities in Malawi, mostly owned by churches. Most of the private universities offer programmes in arts and humanities, business administration, financial accounting and management, procurement and education. Very few private universities offer programmes in science, technology and innovations because they are presumed expensive to run due to demand for laboratory equipment and materials and other infrastructure. There is also higher demand for enrolment in art and humanities programmes than science and technology programmes because of the deficiencies in the entry requirements which is mostly a credit in STEM courses. Most of the students, especially females and students from Community Day Secondary Schools (CDSS), fall short of entry requirements for STEM programmes.

Women participation in Top University Management Positions. Two out of six Vice Chancellors (VC) in public universities in Malawi are women representing 33% while two out of the six Deputy Vice Chancellors(DVC) are women also representing 33% (Table 1). This is an improvement from the past two years, in 2020, where out of the four vice chancellors, only one was a woman representing 25% and all the DVCs in four institutions were men. The presence of women in top university management positions is a positive direction towards embracing gender transformation and is an opportunity for reducing gender inequalities in higher education. Women in top management positions are able to make decisions that can influence change in gender equality and social inclusion.

Students' Choices for STEM Programmes in Public Universities. The 2021/2022 Public Universities selection in Malawi revealed that STEM programmes are unpopular among prospective university students. Out of the 20 top popular programmes according to students' choices, only 7 were STEM related programmes representing 35% (Figure 2). Out of the 7 STEM programmes, 3 were education sciences, 2 were nursing and midwifery related programmes, 1 was Bachelor of Science in Environmental Health and 1 was Bachelor of Pharmacy (Hons} programme. None of the 20 top popular programmes was Engineering, Technology and Mathematics related programme. Full list of the top and least popular programmes is presented in Tables 2 and 3.

Table 1. Gender Representation in University top management positions

University	Vice Chancellor		Deputy Vice Chancellor	
	M	F	M	F
MUBAS		1	1	
KUHES	1			1
UNIMA	1		1	
LUANAR	1			1
MUST		1	1	
MZUNI	1		1	
Total	4	2	4	2

Table 2. The 2021/22 top popular programmes among students' choices

NO	Programme CODE	PROGRAMME NAME
1	UMA-HU	Bachelor of Arts
2	MZU- BED SC	Bachelor of Education (Science)
3	MUB-JOU	Bachelor of Arts in Journalism
4	MUB-BAC	Bachelor of Accountancy
5	KUH-NM	Bachelor of Science in Nursing and Midwifery
6	MUB-BBC	Bachelor of Arts in Business Communication
7	UMA-SSSW	Bachelor of Social Science (Social Work)
8	MUB-BBAG	Bachelor of Business Administration (Generic)
9	MZU-BEDA	Bachelor of Education (Arts)
10	UMA -BEDSED	Bachelor Education (Social Studies)
11	MUB-BAF	Bachelor of Commerce (Banking and Finance)
12	MZU-BED L	Bachelor of Education (languages)
13	MZU-BSNM	Bachelor of Science (Nursing and Midwifery)
14	MZU-BACOS	Bachelor of Arts in Communication Studies
15	UMA-BEDLED	Bachelor of Education (Language)
16	MUB-EH	Bachelor of Science Environmental Health
17	UMA-ECD	Bachelor of Early Child Development
18	UMA-BEDCHE	Bachelor of Education (Chemistry)
19	UMA-BEDMAT	Bachelor of Education (Mathematics)
20	KUH-PHARM	Bachelor of Pharmacy (Hons)

Table 3. The 2021/22 least popular programmes among students'choices

NO	Programme CODE	PROGRAMME NAME
1	MST-MEC	Bachelor of Science in Meteorology and Climate Sciences
2	UMA-SOC	Bachelor of Arts in Sociology
3	LNR-BAQF	Bachelor of Science in Aquaculture and Fisheries Science
4	UMA-SCIFC	Bachelor of sciences in family and consumer sciences
5	MST-GIS	Bachelor of Science in Geo-information and Earth Observation Science
6	MST-PETR	Bachelor in Petroleum Geoscience (Oil and Gas)
7	UMA-BEDHEC	Bachelor of education (human ecology)
8	MZU-BSLPP	Bachelor of Science in Land Management (Physical Planning)
9	LNR-BENE	Bachelor of Science in Environmental Engineering

10	MUB-BPP	Bachelor of Science in Physical Planning
11	MUB-BMEN	Bachelor of Science in Mining Engineering (Hons)
12	MUB-BMMP	Bachelor of Metallurgy and Mineral Processing Engineering (Hons)
13	UMA-SCIPHY	Bachelor of Science in Physics
14	MZU-BSLEM	Bachelor of Science in Land Management (Estates Management)
15	LNR-BHLD	Bachelor of science in Horticultural Sciences and Landscape Design
16	MUB-BGEN	Bachelor of Geological Engineering (Hons)
17	MST-ESC	Bachelor of Science in Earth Science (Geology)
18	MUB-BLE	Bachelor of Science in Land Ecology (Hons)
19	MST-MME	Bachelor of Engineering (Hons) in Metallurgy and Material Engineering)
20	MST-BSS	Bachelor of Science in Sports Science
21	MST-TXE	Bachelor of Engineering in Textile Engineering

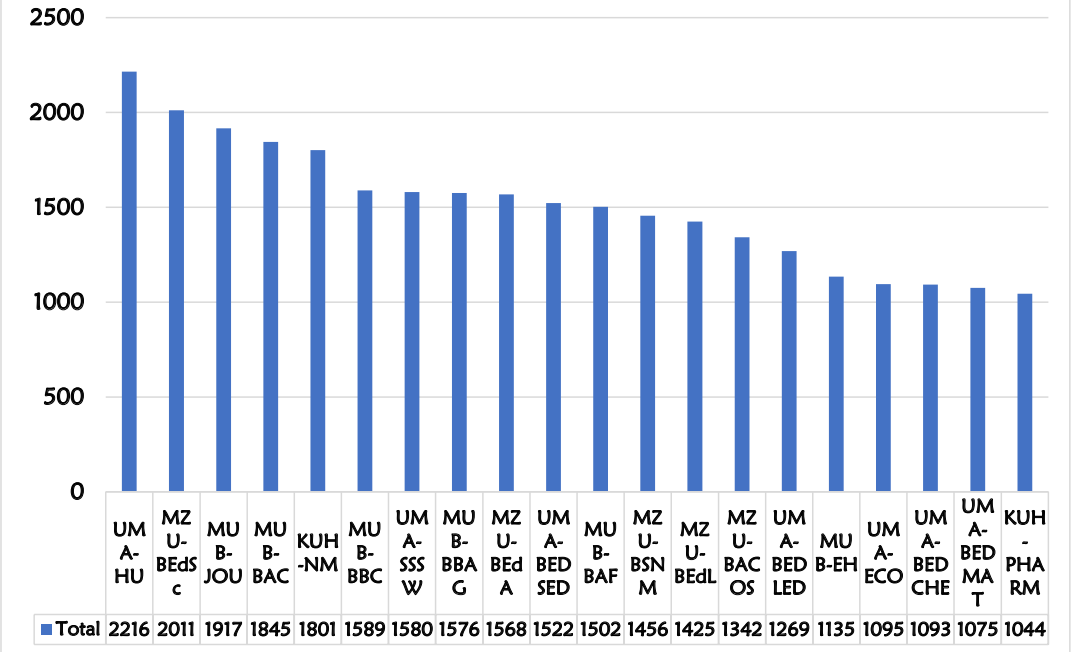

Figure 2. Top 20 Popular Programmes in Public Universities based on number of choices
Source of Data: NCHE

On the other hand, out of the 21 least popular programmes according to students' choices, 19 were STEM related programmes representing 90% while 2 were humanities and Arts programmes (Figure 3). The results imply that secondary school students prefer to pursue Non-STEM programmes at the university. This may be due to the entry requirements for STEM programmes that demand credit passes in science subjects, which most of the secondary school students, especially those

in CDSS, do not have. There is also a perception that STEM programmes are difficult and most of the students who enrol in such programmes in Public Universities are withdrawn on academic grounds. This may also discourage some students to enrol in the programmes. Malawi's economy is agro-based, but Agriculture related programmes are not popular among the students' choices and none of the agriculture related programmes was among the top popular programmes while three were among the least popular programmes. This is worrisome and a threat to achieving Malawi 2063 priority one, which is agriculture-related and requires human capacity building.

Since 2017, the public universities that are mostly science based are very unpopular among the choices of the prospective students. The five-year data on choices for public universities' programmes show that MUST, LUANAR and KUHES were very unpopular among the choices (Figure 4). These three universities offer mostly STEM-related programmes. Findings indicate that UNIMA is the most popular public university among the choices of prospective students probably because it also offers a combination of science, arts and humanities programmes. Overall, the number of students enrolled in STEM related programmes are low while the number of female students is even lower in institutions that are STEM based. This may be attributed to the low performance in science subjects at secondary school which is a requirement in such institutions.

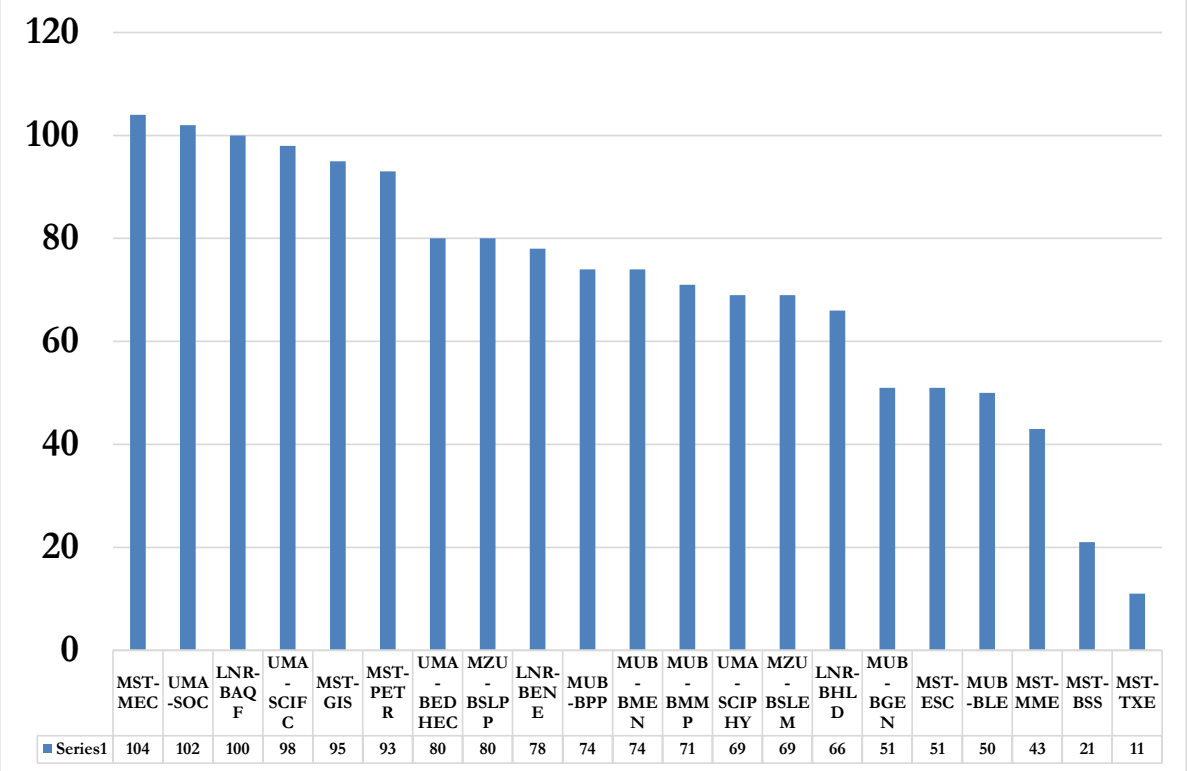

Figure 3. Least 21 Popular programmes in Public Universities based on number of choices
Source of Data: NCHE

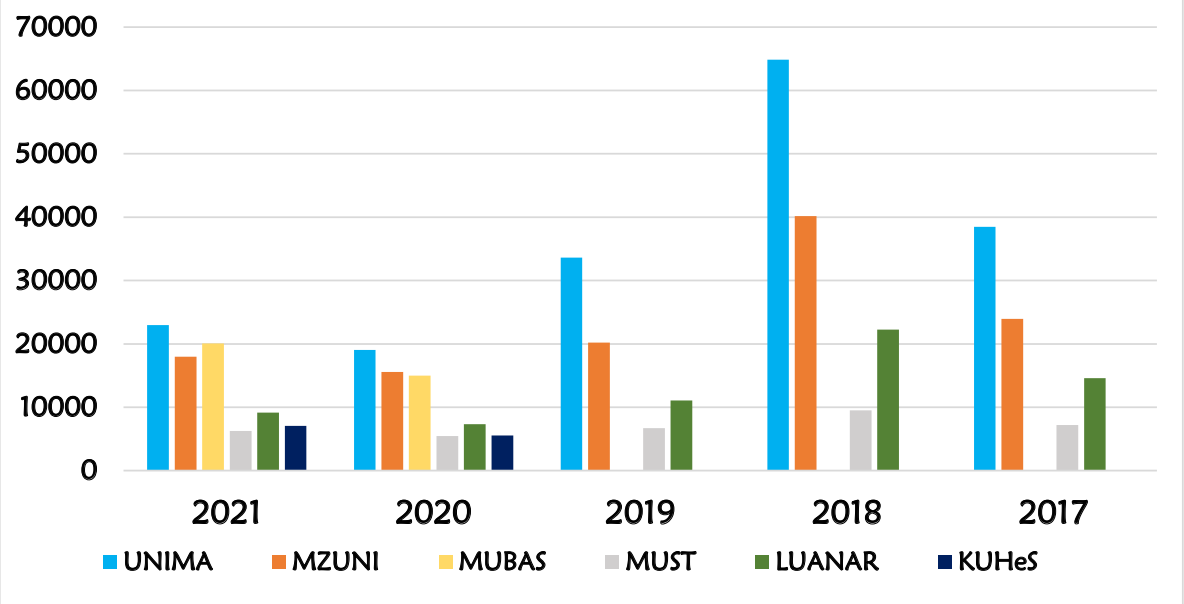

Figure 4. Institution Popularity Based on Number of Choices during Applications.
Source of Data: NCHE

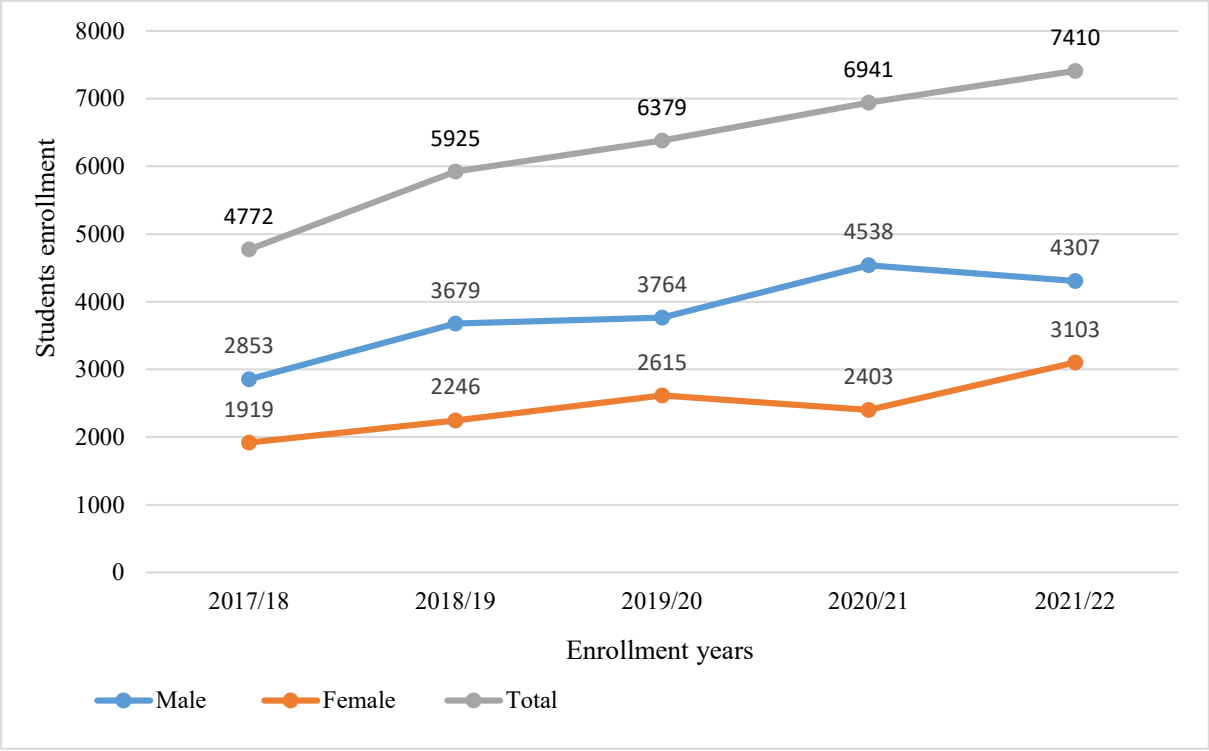

Figure 5. Enrolment of students in public universities from 2017/18 to 2021/22
Source of Data: NCHE

Trends in the enrolment of students in public universities in Malawi from 2017/18 to 2021/2022. The total number of students enrolled in public universities increased from 4,772 to 7,410 representing 36% increase in the past five years (Figure 5). The overall increase in enrolment may be attributed to delinking of UNIMA into three new universities that has resulted in increased enrolment at MUBAS and KUHeS.

The results showed the increase in the number of female and male students enrolled in public universities. It was observed that the rate of increase for female students was higher (38%) than the overall rate of increase (36%) and increase rate for male students (34%). This may be attributed to affirmative action and initiatives that were introduced to increase enrolment of female students in public universities. It should also be noted that the rate of enrolment for female students decreased within the five-year period due to other factors. For instance, there was a drop in the percentage of female students during the 2020/21 academic year (35%), the lowest in the period of five years and all the public universities registered low percentage of female students' enrolment in the academic year (Figure 6). This may have been triggered by COVID-19 related issues because this was one of the years when Malawi experienced adverse effects of COVID-19 and registered a higher percentage of female students who dropped out of primary and secondary school due to unwanted pregnancies or early marriages. The higher education was not spared with COVID-19 effects on female enrolment. The 2021/22 academic year registered the highest percentage (42%) of female students enrolled in public universities and this was a great achievement for Malawi higher education.

In general, the results show that there is a significant increase in the overall enrolment of students and female students, in particular, in public universities. This is an encouragement that the gender gap is decreasing in the enrolment of students in higher education institutions. The SADC recommendation is to have a 50:50 enrolment for male and female students in the region and there are a few countries that have reached the target, however, most of the countries including Malawi are moving in positive direction as it currently stands at 42%.

Gender Parity in ST&I Programmes in Public Universities

Gender Parity in Enrolment in natural sciences Programmes. The enrolment of students in public universities for the past five years, 2017/18 to 2021/22 shows low numbers of students enrolled in ST&I programmes. The results in Figure 7 show that for every female students, less than five enrolled in natural science programmes in 2017. This may be due to cultural and attitudinal perceptions that natural sciences are difficult courses and not suitable for girls. However, the number female students enrolled in statistics and mathematics increased over the years. The increase may be attributed to interventions that encourage participation of female students in STEM programmes.

Gender Parity in enrolment in Nursing and Midwifery Programmes. The trend on enrolment of female students is different for nursing and midwifery programmes where more female students are enrolled than their male counterparts (Figure 8). This may be the case because of the gender inequalities in the division of labour at the household level where girls have roles and responsibilities associated with taking care of children and caring for the sick. The nursing and midwifery profession is perceived as a profession for women. However, enrolment of female students in medicine programmes was at least over 30% and in some years, it was 50%. This implies that female students are competing favourably with male students in health/medicine related programmes.

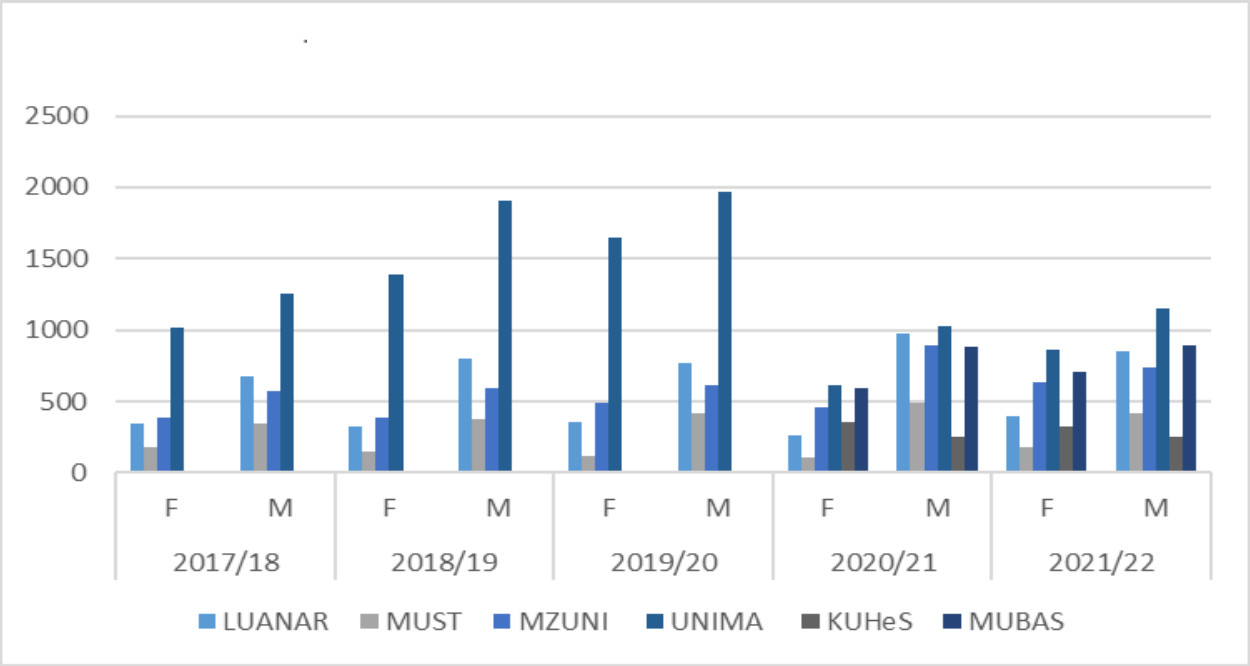

Figure 6. Trends in Enrolment of Students from 2017/18 to 2021/22
Source of Data: NCHE

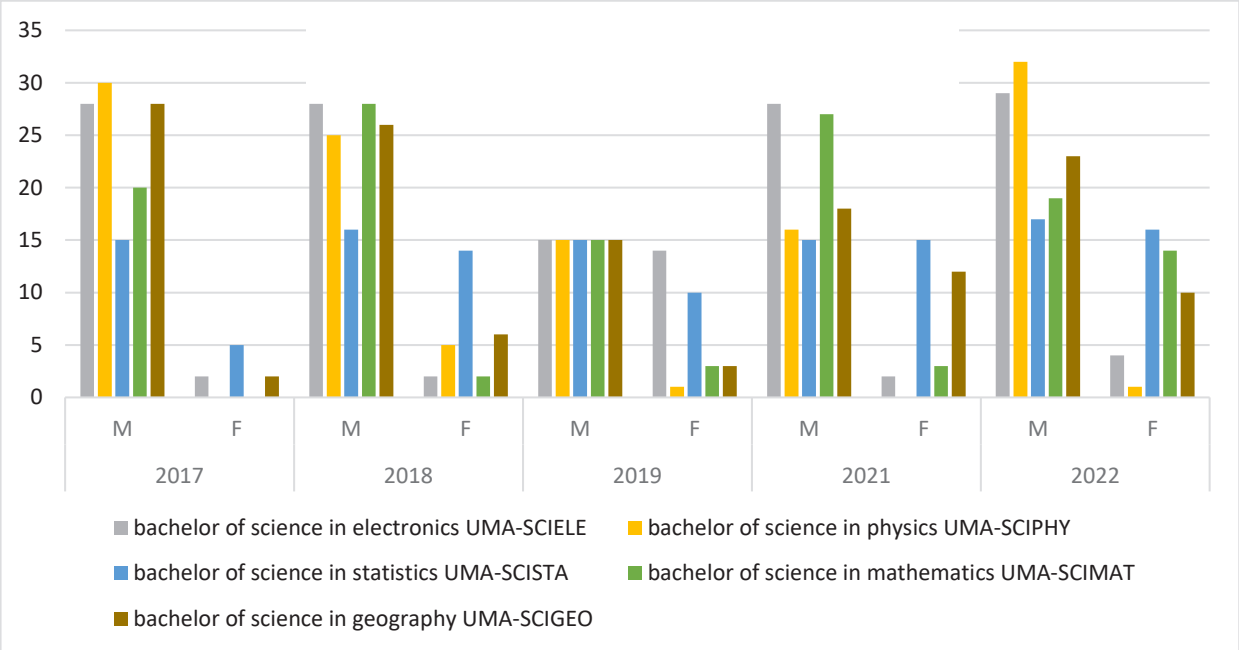

Figure 7. Students enrolment in Natural Science Programmes
Source of Data: NCHE

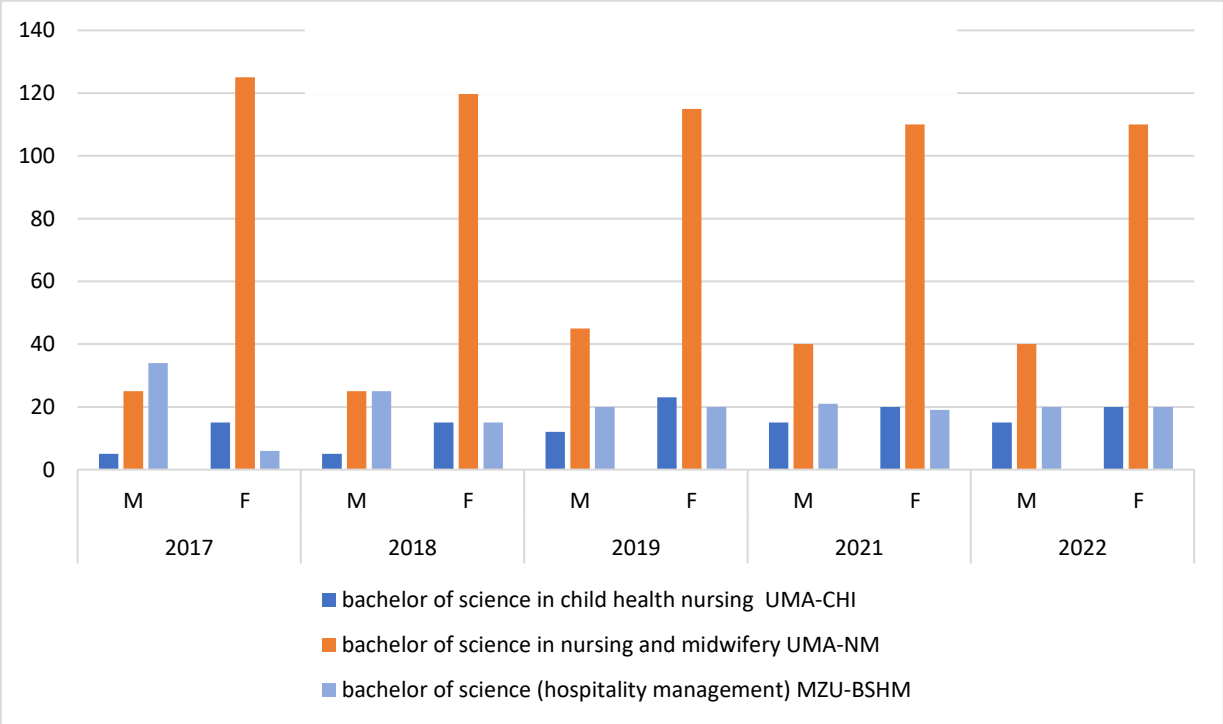

Figure 8. Students enrolment in Nursing and Midwifery Programmes
Source of Data: NCHE

Gender parity in enrolment in engineering programmes. The results showed low numbers of female students enrolled in engineering related programmes between 2017 and 2022 (Figure 9). However, the numbers of female students enrolled in computer network engineering improved over the five years. The results also showed that textile engineering is not popular among female students as it registered very low numbers and there was no female student in 2019 and 2022 selection. This is unexpected as women are associated with textiles and design and one would expect the programme to attract more female than male students. Overall, the results show that engineering programmes are still dominated by male students and no progress has been made to attract more female students over the past five years.

Gender parity in Information system and geo-science Programmes. The findings showed that female students are under-represented in information systems and geoscience programmes, mostly with less than five female students (Figure 10). While the number of female students enrolled in petroleum geoscience programme kept on decreasing over the years, the number of female students enrolled in geo-information and earth observation science increased especially in 2022. Since this is slightly a new programme, the female applicants may have been motivated by other female students that are pursuing the programme. The absence of female role models in the programme may have demotivated female students to apply.

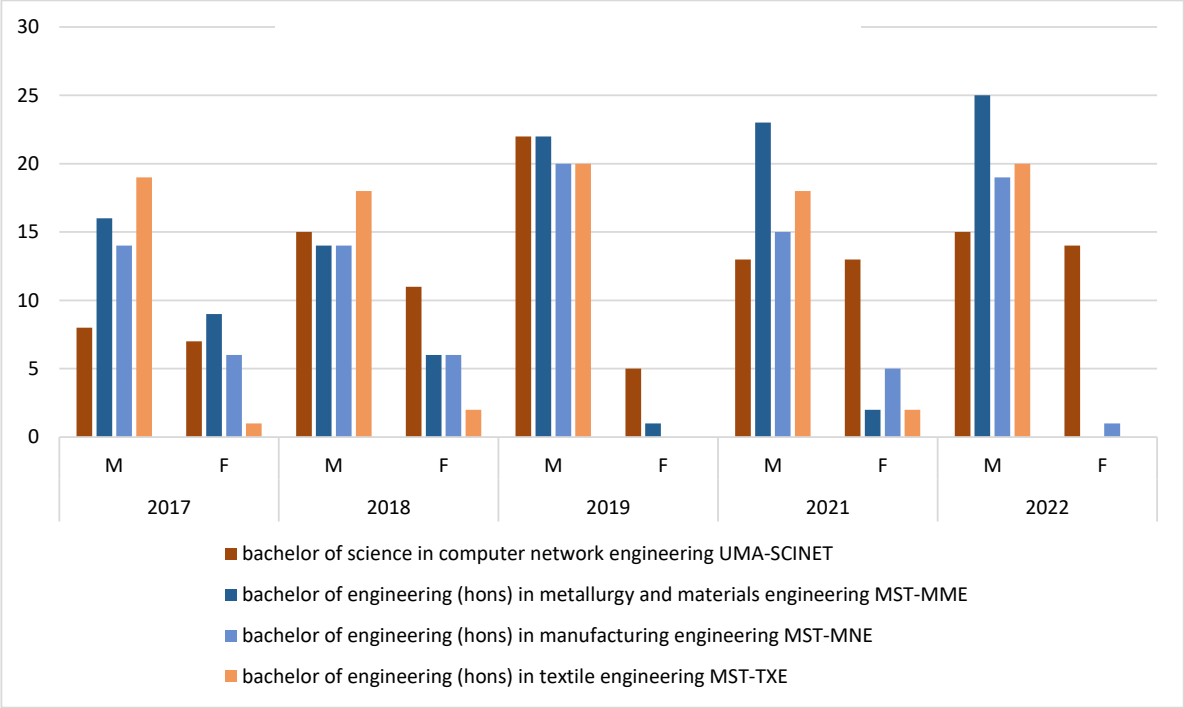

Figure 9. Students enrolment in engineering related Programmes
Source of Data: NCHE

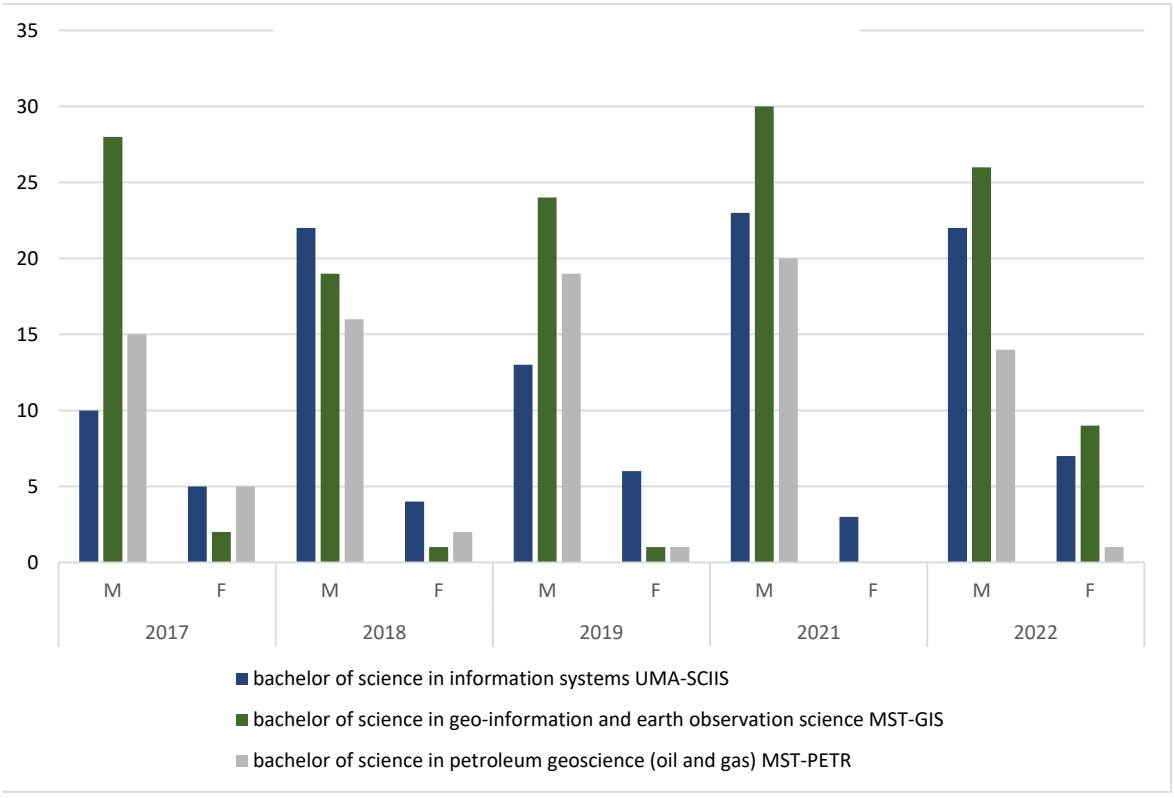

Figure 10. Students enrolment in information system and geo-science programmes
Source of Data: NCHE

Gender disparity in water and land resource management programmes. The results showed that very few female students, less than 10 enrol in water resource management and land management programmes (Figure 11). However, the number of female students enrolled in land surveying increased overtime and in 2022, there were more female than male students who were enrolled in the programme. One would expect more female students to be attracted to water resource management and development since most of the women's household roles use water, but very few female students enrol in the programme. Consequently, women are underrepresented in water utilities. The World Bank report of 2019 revealed that the percentage of women in water services in Malawi was very low. There were a total of 2328 employees in the five boards in 2018 and of these, 349 were women representing 15% of total employees (World Bank, 2019). This was due to the low number of female graduates from technical programmes such as civil engineering and plumbing. Culturally, these programs are considered to be appropriate for men.

Gender Assessment in Technical Entrepreneurial Vocational Education and Training. The overall enrolment of students in Malawi's technical colleges has increased over the past years due to introduction of the eleven new community technical colleges. However, due to the limited number of spaces available in training colleges, the number of enrolled students versus the number of applicants is still very low compared to other SADC countries. In the SADC region, TEVET Malawi ranked the lowest among its peers with only 0.2% of the population aged 15-24 years, enrolled (UNESCO, 2013).

According to TEVETA's annual reports, the enrolment of females in technical programmes is less than 40% (Figure 12). For example, the number of females enrolling in technical programmes at public and private technical colleges was 29% in 2014 and 35.5% in 2015. In 2016, the total intake was an all-time high of 1909 students with 28.4% females. In 2017, although more than 11,000 applications were received from potential students, only 1491 students (469 females [31.5%] and 1022 males) were eventually enrolled. Even with the increase in overall enrolment, the enrolment of female students and Students with Disabilities (SWD), has seen only modest changes. In 2017, the overall enrolment, as well as the number of female students, declined slightly.

The results also showed that the participation of female students in ST&I programmes at TEVET was very low. Most of the ST&I programmes were dominated by male students. The overall range of female students in the three male-dominated trades between 2014 to 2017 was 1 to 6 females per course. Most of the instructors for ST&I programmes in TEVET are males. Figure 13 indicates that male instructors dominate in capentry and joinery, auto mobile networks and electrical installation. Some programmes do not have female instructors. Role models play a key role in motivating female students to pursue programmes that are perceived to be male-dominated. The construction trades such as carpentry and joinery, electrical installation and ICT studies are also dominated by male students while tailoring, business administration and administrative studies are dominated by female students. A study by UNESCO in 2018 revealed a number of barriers to women participation in ST&I that included: traditional stereotypical attitudes and cultural beliefs; education deficits in enrolmment requirements and lack of role models.

Women Participation in Science, Technology and Innovations. There are a total of 201 Malawian women with doctoral degrees and these include those staying in Malawi and diaspora. Most of these women are working in the academia

followed by medicine and health. However, it should be noted that some of the women in the academia are teaching STEM courses. Out of the 56 women in academia, 22 are teaching STEM courses in higher education institution. They are very few women with doctorate degrees in science and technology who are working as technical experts in the industry. The other group of women in science, Technology, Mathematics and Engineering has a total of 229 members. These include women with Bachelors, Masters and PhD degrees. To date there is no proper profiling and tracking of women in STEM. It is therefore a challenge to report the accurate number of women in STEM. The National Commission for Science and Technology in collaboration with the Directorate of Science and Technology in the MOEST are working towards profiling women in science and technology.

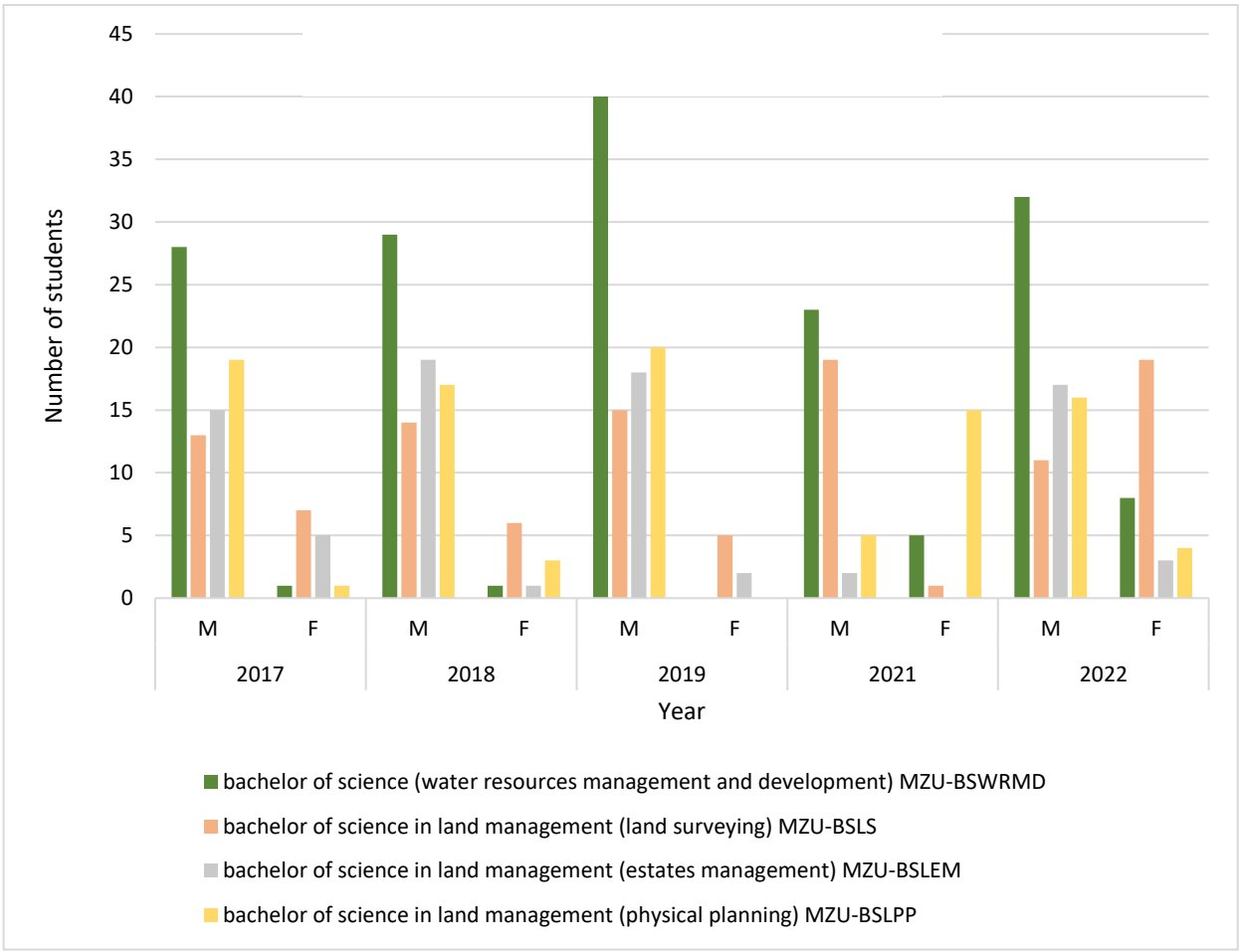

Figure 11. Students enrolment in water and land resource management programmes
Source of Data: NCHE

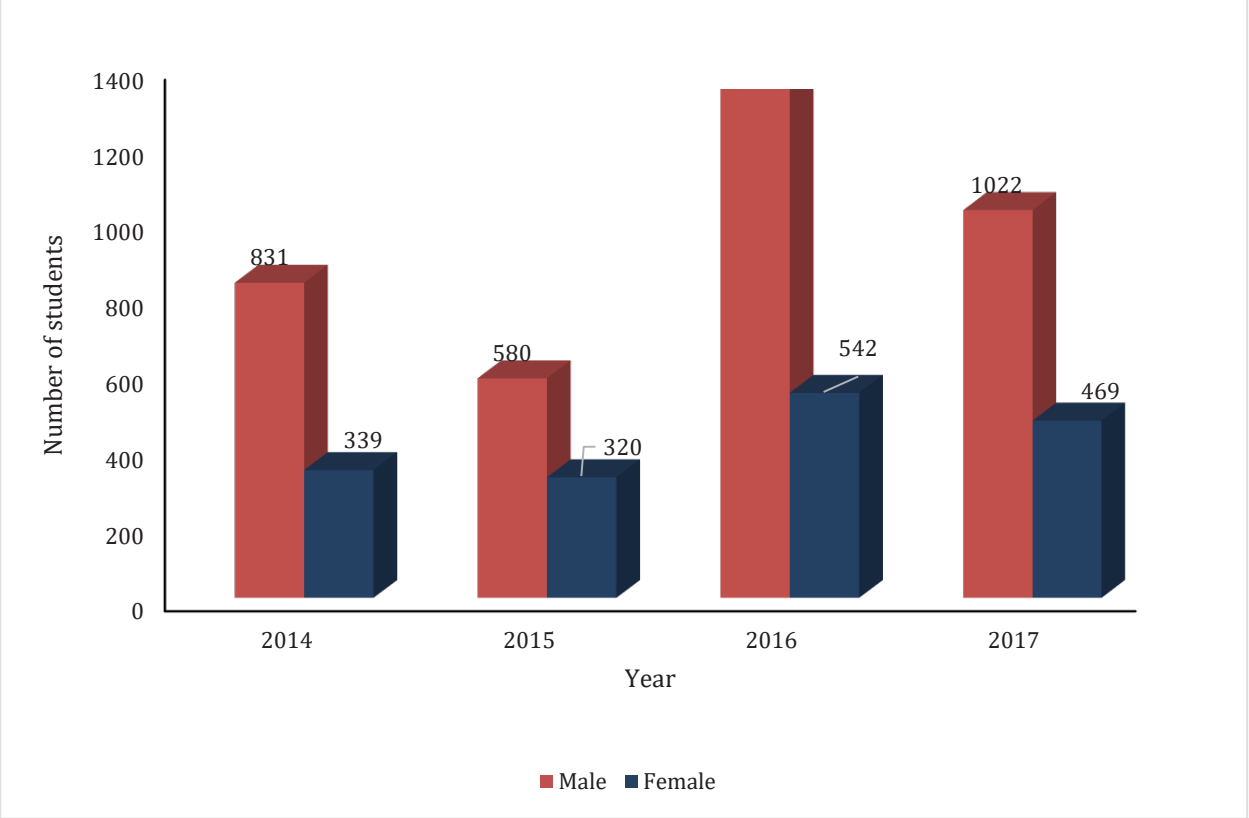

Figure 12. Students enrolment in technical colleges from 2014 to 2017
Source: The UNESCO STEP Gender equality and Inclusion report, 2018

CONCLUSION AND RECOMMENDATION

There have been initiatives to address gender parity in ST&I and increase participation of women in higher education ecosystem. The initiatives included development of policies to attract more female students in STEM programmes, increase participation of women in decision making in ST&I and higher education as well as promoting ST&I. The National Council for Science and Technology and the Directorate of Science and Technology in the Ministry of Education, Science and Technology were established to advance science, technology and innovations. However, despite the initiatives, the gender inequalities still exist in enrolment of students in higher education in STEM programmes. The analysis on students' enrolment in public universities showed that female students are underrepresented in science, technology and innovations programmes and the trend has not improved over five years. This is a threat to realisation of Malawi 2063 agenda as women may be left out in the advancement of technology and innovations that may lead to industrialisation and urbanisation. Although over 70% of full-time farmers in Malawi are women and they contribute greatly to the production of food crops, their participation in decision making in agricultural technologies, innovations and research is low because they are underrepresented in agricultural related programmes. This raises questions on how women will contribute to increased agricultural productivity and commercialisation in Malawi. This calls for holistic approach and a review on interventions targeting women participation in ST&I.

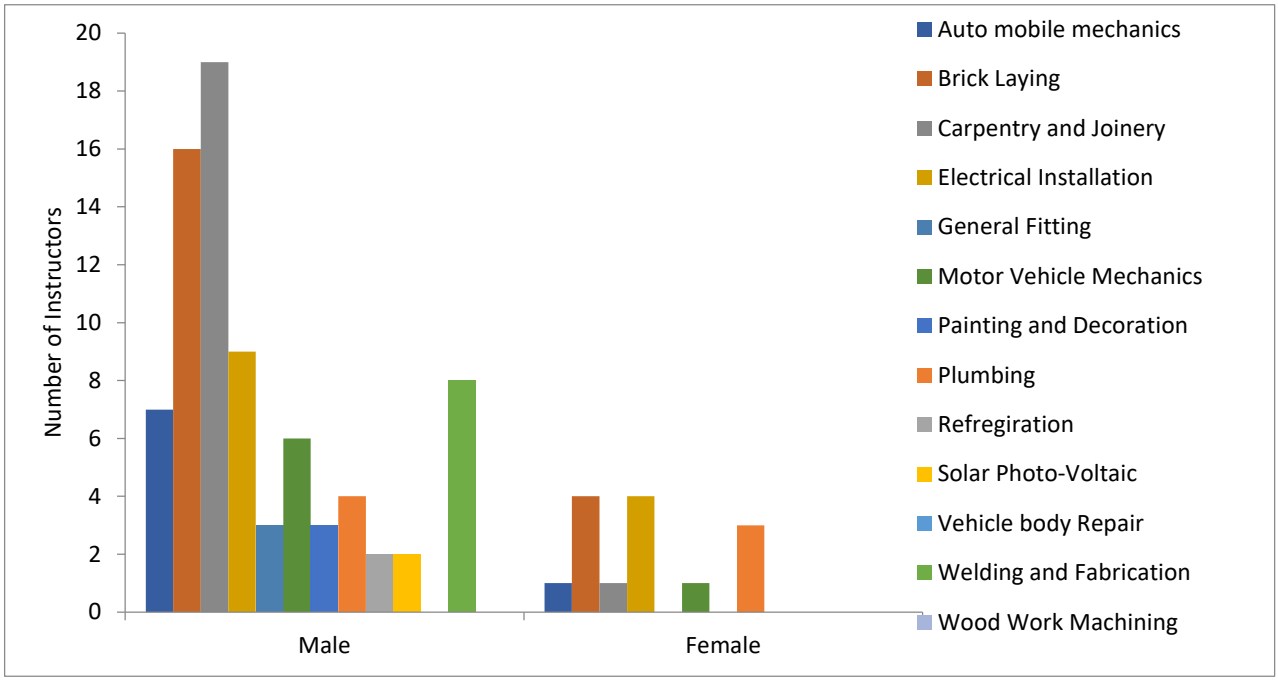

Figure 13. Priority Programmes by male and female students

Based on the findings, the following policy and programming recommendations are made:

1. Directorate of Science and Technology in collaboration with Directorate of Higher Education should develop and update policies clearly identifying strategies to increase access and success rates for female students and students with disabilities in ST&I.
2. National Council for Higher Education in partnership with Directorate of Higher Education and Directorate of Science and Technology should develop a holistic approach in addressing traditional stereotypical attitudes and cultural beliefs. A series of packages on sensitisation and career guidance materials suitable for upper primary and secondary school students, their parents/ guardians, and rural community leaders should be developed to address this issue..
3. The National Council for Science and Technology in collaboration with the Directorate of Science and Technology should have a database and profiles of women in ST&I including mapping the work they are doing.
4. Universities should strengthen initiatives to attract more female students to ST&I programmes. This should include offering scholarships for female students pursuing STEM programmes.
5. Universities should put in place students support services such as remedial lessons and tutoring for students who do not perform well in STEM programmes.
6. NCHE in collaboration with universities should develop a curriculum for bridging STEM courses to target students with low grades in sciences from secondary schools.

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STATEMENT OF NO CONFLICT OF INTEREST

The authors declare that there are no competing interests in this publication.

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