An Artificial Intelligence based model for gender inequality analysis in STEM programs and career projection in Kenya.

Overview: Despite current gender educational regulations and other interventions aimed at ensuring gender equity, equality and inclusion, it remains a major issue in Kenya. STEM education is intended to equip students with the knowledge, skills, attitudes, and behaviors required to thrive in an inclusive and sustainable society. A recent study by UNESCO shows that only 35% of all students enrolled in STEM related subjects at higher learning institutions are female students. This study intends to examine the participation of female students' in STEM courses by investigating how gender inequality affects student placement and students' perceptions of AI in STEM programs and eventual work placement. In addition, the study will investigate the ethical purpose and societal benefit of AI application use.

Introduction: In furtherance of the theme on gender inequality in STEM Education and responsible Artificial Intelligence, this study proposes to work on the following key issues: i) Assessing the factors that have led to low number of women in the Artificial Intelligence ecosystem that is academia and Industry; ii) Determining the female student's perception towards STEM programs; iii) Determining the applicable interventions to encourage gender inclusivity in the STEM space; iv) Developing an analytical model for gender inclusivity in STEM programs, v) Determining the manner in which AI is compatible with human agency, human autonomy and the respect for fundamental human rights (including freedom from discrimination); vi) Assessing the implementation of AI systems and to act to mitigate against consequences of AI systems (whether intended or unintended) that are inconsistent with the ethical purposes of beneficence and non-maleficence and vii) Assessing the social, political and environmental implications of such development, deployment and use in the context of a structured Responsible AI Impact Assessment that assumes risk of harm and, as the case may be, proposes mitigation strategies in relation to such risks.

Research problem

STEM provides tremendous advantages to Kenya's economy, but these benefits may not be completely realized due to lack of gender inclusivity in STEM programs. STEM students are underrepresented in higher education, particularly among female students. 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 labor 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 underrepresentation of women in STEM hinder realization of the United Nations Sustainable Development Goals like eradicating hunger and poverty (Amunga & Amadalo, 2020).

To address these gaps, this study will be based on the Social Constructionist Theory (SCOT) (Nightingale & Cromby,1999). The social constructionist theory will be employed in this study

to explain poor female involvement in STEM programs, especially in AI. This could be as a result of social construction of female students into stereotypically feminine fields, societal expectations, and gender roles. In terms of gender responsiveness in STEM curricula, the theory will explain the low involvement of female students in AI within STEM.

Problem Justification

STEM education gives people skills that make them more employable and ready to meet the current labor demand. It encompasses the whole range of experiences and skills. It prepares professionals who can transform society with innovation and sustainable solutions. The STEM approach to education fosters creativity and divergent thinking alongside fundamental disciplines. STEM education prepares the world for the future. It is based on teamwork and the collaboration of professionals from different disciplines. STEM education enables people to make informed decisions within the discussed subject areas. STEM awareness promotes interest in a range of exciting careers.

One of the goals of STEM initiatives is to encourage broader participation of women and minorities in the STEM workforce. This allows us to bridge ethnic and gender gaps. There is a need for the engagement and participation of learning institutions, policymakers, parents, students, and educators to continue technological and scientific progress. The world we live in is changing, and we must keep pace with it. STEM education changes society by offering learners a new mindset and skills valued in any profession. They allow young people to be flexible, look for patterns, find connections, and evaluate information. Besides, STEM education raises social awareness. It communicates global issues to the general public. Therefore, STEM opportunities move us to a knowledge-based sustainable economy.

Objectives and Research Questions

General objective:

To determine STEM gender inequality using a Machine Learning Model in tertiary learning institutions and industry.

Specific objectives:

   i.   To establish the trends in female uptake of STEM courses from 2012 to 2021 via Kenya Universities and Colleges Central Placement Service (KUCCPS)
   ii.   To investigate how gender inequality influences student placement in STEM programs
   iii. To investigate the female students' perception towards AI in STEM programs
   iv.   To recommend strategies for improving AI use among female in STEM programs
   v.   To disseminate knowledge for decision-making with the purpose of informing strategies for reducing gender inequality in the AI use

   vi.   To determine the ethical purpose and societal benefit of AI use

Research questions:

The research questions to be investigated include:

1. What are the trends in female uptake of STEM courses from 2012 to 2021 via Kenya Universities and Colleges Central Placement Service (KUCCPS)?
2. How does gender inequality influence student placement in STEM programs?
3. What are the female students' perceptions towards AI in STEM programs?
4. Which strategies should be put in place to improve AI use among females in STEM programs?
5. Which approaches should be employed to disseminate knowledge for decision-making with the purpose of informing strategies for reducing gender inequality in AI use?
6. What are the ethical purposes and societal benefits of AI use?

Literature Review

The term STEM (Science, Technology, Engineering and Mathematics) is progressively becoming an important fixture in education and the world economy. The reason for this is that the careers of the future will most certainly be centered around STEM fields, while also invoking 21st century skills such as critical thinking, creativity, cultural awareness, collaboration and problem-solving. STEM, particularly Internet of Things, Big Data, and Artificial Intelligence, is radically reshaping our society and the work market. This social change necessitates the education of students who are prepared to learn and develop skills such as communication, critical thinking, creativity, and collaboration in order to successfully enter the labor and social worlds, where they will be required to solve problems in a global and changing environment.

According to Opera news, the permanent secretary for education in Kenya decries low enrolment of women in STEM programs in universities calling for actors in the education sector to ensure the gender gap is filled. According to Mukhwana *et. al* (2016), 74% of Every university student studies business, education, arts, and humanities. This leaves only 26% of students in STEM fields. According to a UNESCO study 'STEM and Gender Advancement project' launched in 2015, 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 enrollment. 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 (Chavatzia, 2017). According to the European Commission's 2018 report, there is a rising gender gap in digital engagement. 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.

The low number of women in the AI field, including academia and the AI workforce, contributes to gender inequality. A report to investigate the proportion of women in the AI workforce found that women have a lower AI skills penetration rate than men in the majority of the developed countries. Complemented by the wide digital divide within the developing countries, the AI skill penetration rate for women is likely to be even smaller. Careers in STEM fields are now commonly

cited as future jobs that are being used and will continue to be used to propel innovation, inclusive growth, and long-term sustainability. In order to draw women into STEM fields, education sector stakeholders must provide training and mentorship in these areas. By so doing, women will be given the chance to contribute to the advancement of society.
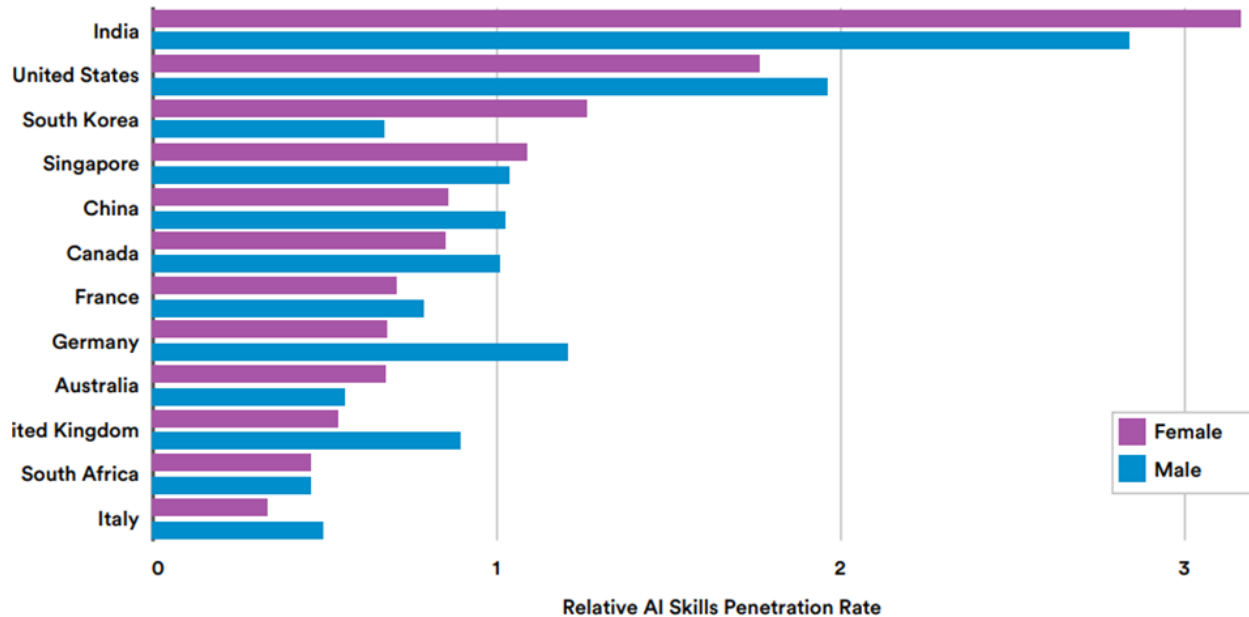
Relative AI skills penetration rate by Gender, 2015-2021 (Source: LinkedIn, 2020 | Chart: 2021 AI Index Report)

Research findings on the Status of Women (UNESCO, 2010) suggest that STEM courses are vital drivers needed to expedite the fulfillment 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 inequality. 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.

The realization of AI advantages in Kenya necessitates the development of workforce skills that can encourage responsible use of AI. This can only be achieved by addressing the gender inequality gap to increase female participation in developing competent AI expertise that will produce relevant AI solutions across several sectors.

Methodology

This study will employ a mixed research design that will include both qualitative and quantitative techniques. The approach is suited for this study as it seeks to establish interventions to promote female students to utilize AI in STEM and education programs at Kenyan public institutions. Both Qualitative and quantitative data will illuminate the current status of gender inequality among

STEM programs. The qualitative data will provide background and contextual information pertaining to the students' perception and uptake of STEM programs. Qualitative research will be conducted through focused group discussions and key-informant interviews amongst female students, and actors/stakeholders. The quantitative data will provide the current status of the female participation in STEM. Additionally, the qualitative approach will help elicit the extent to which the female students' perception have resulted in low enrollment into STEM programs. The Quantitative approach will focus on past enrolment data set, analysis and reporting tools, and predict future patterns of female actors' uptake of STEM programs. Purposive sampling techniques will be used as the focus is on students taking STEM programs that incorporate Artificial Intelligence in their curriculum and the limitation in the number of institutions offering STEM programs and employment opportunities. Approximately 100 DeKUT female in STEM students will be sampled. Primary data will be collected from KUCCPS' repository and select institutions of higher learning to establish female student enrollment over the years into STEM programs. The proportionate enrollment rates derived from the dataset will inform the universities to target for the qualitative data collection seeking female students' perception towards AI use. Additionally, data will be collected from industry to evaluate the gender gap in STEM related industries.

In addressing specific objectives, for each objective, a number of steps that will be taken are highlighted in the following section:

For the first objective, thus "To establish the trends in female uptake of STEM courses from 2012 to 2021 via Kenya Universities and Colleges Central Placement Service (KUCCPS), the data received from KUCCPS will be analyzed in our model and validated by the stakeholder.

For the second objective, thus, "To investigate how gender inequality influences student placement in STEM programs": The Analytical model developed in this study, will be used to determine how gender inequality has influenced placement of students in STEM programs.

For the third objective, thus "To investigate the female students' perception towards AI in STEM programs". The Analytical model developed in this study, will be used to determine the students' perceptions towards AI in STEM programs.

For the fourth objective, thus, "To recommend strategies for improving AI use among females in STEM programs" A report will be created that highlights the recommended strategies that could be applied to improve AI use among females in STEM programs.

For the fifth objective, thus, "To disseminate knowledge for decision-making with the purpose of informing strategies for reducing gender inequality in AI use": A workshop will be organized to enable discussions on the findings of the research work. The output will also be published in peer reviewed journals and/or conference proceedings.

For the sixth objective, thus, "To determine the ethical purpose and societal benefit of AI use": The study will ensure voluntary participation of respondents with privacy and anonymity being of paramount importance. The moral principles and techniques intended to inform the development and responsible use of AI technology will be discussed.

Expected Results

The study will generate contextual barriers that hinder the uptake of AI in STEM programs by female students. Additionally, the study will generate a dataset denoting the STEM courses uptake in the period 2012 to 2021. The outcome will be an analytical model for providing the current status and predicting future female participation in STEM programs. The study findings will be disseminated via publication and workshop presentation

In objective 1 that seeks to assess the uptake of STEM courses by female students, the study will give a statistical representation of stem courses uptake by female students in comparison to other courses and the extent to which gender in/equality has been accommodated. The outcome will be a review paper.

In objective 2 that seeks to investigate how gender inequality influences student placement in STEM courses, the study will generate an analytical model that shows the possible trend of gender in/equality in student placement in STEM programs. This will culminate in a workshop presentation.

In objective 3 that seeks to investigate the perception of female students in STEM programs towards AI, the research will present contextual factors that influence the uptake of AI in STEM programs by female students guided by the Social Constructionist Theory [4]. The outcome will be a research paper.

In objective 4 that seeks to recommend strategies for improving AI use among females in STEM programs, the study will produce actionable strategies that relevant stakeholders can adopt to improve AI use. The outcome will be a position paper.

In objective 5, the study will seek to disseminate knowledge for decision-making with the purpose of informing strategies for reducing gender inequality in AI use. The outcome will be a position paper.

In objective 6, the study will produce a report on ethical AI use and societal benefit. This describes the moral principles and techniques intended to inform the development and responsible use of AI technology.

Ethical Considerations:

The study will adhere to ethical guidelines for research involving human participants, including obtaining informed consent from all participants and ensuring confidentiality and anonymity of participants' data. The respondents during focus groups and interviews will be given information about the study and their voluntary participation sort. All respondents will be required to sign a consent form. To be able to acquire data on female uptake of STEM courses from 2012 to 2021 from KUCCPS, research permit from NACOSTI will be sort which will then be present to KUCCPS.

Achievements and Innovations:

The study adopts SCOT in assessment of the female perception towards AI in STEM programs and career. The gender inequality on AI in STEM programs findings will inform policy in the realization of Kenya Vision 2030 and UN SDG goals. Additionally, the findings will provide insights to develop strategies to bridge the gender gap challenge in enrollment to STEM courses in the higher education institutions and career projection.

Using responsible AI, we will develop a data analytics model that will give insights about gender inequality and inclusion in STEM. We will present facts about the STEM gap and why it is important to mitigate the gap by getting more female students in STEM programs and work placements. The study intends to demonstrate that STEM drives the economy and opens up employment opportunities and should be promoted by instituting policies that enhance retention of women in STEM careers. It is expected that these should enhance women's participation in STEM based programs so that they can build capacity in those areas.

Activities and deliverables:

Activities proposed	Timeline	Deliverables(D)/Milestone s (M)
● Quantitative Data Collection, compilations, cleaning and analysis of KUCCPS placement from 2012 to 2021 ● Systematic review of recent works	Month 1 - Month 4	● A report showing Visual representation through graphs showing trends on female students' uptake on STEM courses for the period 2012 to 2021 ● A review paper
● Qualitative Data Collection(participant recruitment, data collection, Analysis) from industry and academia.	Month 3 - Month 4	● A multi pathways of factors contributing to the interest in STEM courses ● A strategy to improve the uptake of STEM programs by the female in academia and career projection in industry
● Develop an analytical model using the KUCCPS student placement dataset to investigate gender inequality during student placement and career projection in industry	Month 5 - Month 8	● An analytical model showing how gender inequality may influence student placement by KUCCPS and career projection in industry ● An improved algorithm that best addresses the gender inequality in STEM courses. ● Strategies to reduce gender inequality in student placement in STEM courses. ● Workshop Presentation ● A Paper Publication

About the Researchers:

The school of Computer Science and Information Technology has the appropriate skills and experience to be able to meet the expectations of the call. Our researchers have prior experience in both thematic and data driven research. The school is focused on technological innovations using AI, big data and analytics, IoT, and cybersecurity that can be deployed to tackle Africa's pressing problems in health, education, environment and agriculture. The skill-base is built on skills and experience acquired by the group centered on data and knowledge. In this context, our research is currently divided in two areas of expertise: Deductive systems for producing knowledge by reasoning and inductive systems for producing knowledge from data.

References

1. Mukhwana, E., Oure, S., Kiptoo, S., Kande, A., Njue, R., Too, J., & Some, D. K. (2016). State of university education in Kenya. *Commission for University Education. Discussion Paper*, *4*(3)**.**
2. Chavatzia, T. (2017). Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM). Paris, France: UNESCO.
3. European Commission. Women in the Digital Age. 2018. Available online: https://op.europa.eu/en/publication-detail/-/publication/84bd6dea-2351-11e8-ac73-01aa75ed71a1
4. Nightingale, D., & Cromby, J. (1999). *Social constructionist psychology: A critical analysis of theory and practice*. McGraw-Hill Education (UK).
5. Amunga, J., & Amadalo, M. M. (2020). The Gender Stem Gap and Its Impact on Sustainable Development Goals and the Big Four Agenda in Kenya: A Synthesis of Literature.
6. Kibet, C. N. (2020). *An Artificial Neural Network Model For Predicting Attainment Of The 50: 50 Gender Ratio In Stem Courses In Kenya* (Doctoral dissertation, Kca University).
7. Ahmed, S. (2021). A Gender Perspective on the Use of Artificial Intelligence in the African Fintech Ecosystem: Case Studies from South Africa, Kenya, Nigeria and Ghana.