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Gendered Journeys: the trajectories of STEM students and graduates through higher education and into employment, in India and Rwanda

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Abstract: Promoting early interest in STEM and role identification for girls, is of urgent interest for many global initiatives (e.g. Organization for Women in Science in the Developing World, 2021). Increasing proportions of girls and women studying and working in STEM would contribute not only to scientific development but to more equitable and sustainable societies, including gendered economic outcomes. However, any focus on recruitment must also focus on retention and progression of women studying and working in STEM, including identifying barriers at key transitional stages of one's 'STEM journey'. Therefore, our project - ***Gendered Journeys: the trajectories of STEM students and graduates through higher education (HE) and into employment, in India and Rwanda***, focusses on gender inequalities in STEM in India and Rwanda, in order to cross-culturally explore gendered inequalities in STEM beyond the dominant literature from North America and Europe. In this briefing paper, we briefly look at the global context before exploring the complex and intersectional nature of gender inequalities in STEM fields in India and Rwanda in particular, drawing on the WEF 2020 Gender Gap report. Given this context, we proceed to describe how our project will contribute to the ongoing work that aims to understand why these inequalities persist and develop interventions, particularly online interventions to tackle the imbalance, and prevent inequalities from widening, particularly in a post-Covid 19 environment.

Keywords: Gender, women, STEM, Educator, Access, Student, employers

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Introduction

The disciplines of science, technology, engineering, and mathematics (STEM) are central to tackling current and future challenges, such as the climate crisis, stark social and economic inequalities seen across the world (UNESCO 2015, 2017) and recovery from the Covid-19 pandemic. The 2020 Gender Gap report by the World Economic Forum highlights that girls and women are underrepresented in STEM in all levels of education, as well as employment, globally, and are less likely to be employed in professional and technical roles generally (WEF, 2020). STEM fields are adversely affected by the potential attrition and subsequent loss of skills of women and girls (e.g. Graham et al, 2013), yet their lived experiences could be vital tools in creating solutions to local and global problems (for instance in technology and data deficits, Perez, 2019).

Promoting early interest in STEM and role identification for girls, is of urgent interest for many global initiatives (e.g. Organization for Women in Science in the Developing World, 2021). Increasing proportions of girls and women studying and working in STEM would contribute not only to scientific development but to more equitable and sustainable societies, including gendered economic outcomes. However, any focus on recruitment must also focus on retention and progression of women studying and working in STEM, including identifying barriers at key transitional stages of one's 'STEM journey'. Therefore, our project - *Gendered Journeys: the trajectories of STEM students and graduates through higher education (HE) and into employment, in India and Rwanda* [1], focusses on gender inequalities in STEM in India and Rwanda, in order to cross-culturally explore gendered inequalities in STEM beyond the dominant literature from North America and Europe.

In this briefing paper, we briefly look at the global context before exploring the complex and intersectional nature of gender inequalities in STEM fields in India and Rwanda in particular, drawing on the WEF 2020 Gender Gap report. Although the WEF has been criticised for its own lack of diversity (TNI, 2016), the Gender Gap report provides a detailed representation of gender inequalities by calculating an overall gender gap score from four sub-indexes: political empowerment, economic participation and opportunity, educational attainment, and health and survival. These statistics alone cannot give the whole picture, but they provide the broader landscape of gender in/equality in our countries of interest. Given this context, we proceed to describe how our project will contribute to the ongoing work that aims to understand why these inequalities persist and develop interventions, particularly online interventions to tackle the

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Gender representation in STEM: a global issue

At present, girls and women are markedly underrepresented in STEM areas both as students and in the workforce in most countries across the globe. At Higher Education level, roughly 30% of students enrolled in STEM studies internationally are (identified as) women (UNESCO, 2017). In certain STEM areas the picture is even starker – for example, the percentage of women in ICT internationally is given as 3%, and at 5% in natural sciences and mathematics and statistics respectively. This of course masks a lot of variation across countries and regions – for example 16% of students in natural sciences, mathematics and statistics in Côte D'Ivoire are women, compared to 86% in Bahrain (UNESCO, 2017). These variations support arguments that patterns of gender representation in STEM cannot be understood as the result of fixed, unchanging biological differences between two neatly categorised sexes – rather we need to look further at the role of social, social psychological and cultural influences.

Work in this area can also focus overly on the level of the individual (Archer et al., 2017). Focusing primarily or solely on the encouragement of individual girls and women into STEM pathways – at the expense of addressing potential inequities in established educational and organisational cultures and practices - can risk implying that the main, or only thing we need to do is to 'fix' individuals' lack of motivation or self-confidence.

Taking such a broader perspective, feminist research indicates the need to challenge and change institutional cultures and practices (see e.g. Leathwood and Read, 2009; Cebula et al., 2020), as well as challenging widespread social discourses that construct girls and women as seemingly innately less able in relation to STEM subjects in comparison to boys/men. Such perceptions infuse educator and parent-guardian expectations, and influence students' own self-perception as to their capabilities, enjoyment and interest in a line of study (Archer et al., 2012). Our interdisciplinary and multi-method approach aims to take such an approach in exploring these dynamics in our countries of focus.

Gender and STEM in Rwandan HE and Employment

The quota of 30% female parliamentarians, as prescribed by the Rwandan constitution, combined with strong political will, gender responsive policies and legal environment as well as enhanced capacity and mentorship for women led to increased representation of women in decision making bodies and improved gender responsiveness of development programmes (RWN, 2019). In the WEF (2020) gender gap report, Rwanda is ranked 9th overall with a gender parity score of 0.791. The gender parity score is a number between 0 and 1, where 0 is the lowest possible score, and 1 is the highest, representing full equality between men and women. In this case, men in Rwanda overall fair better than women at a ratio of 1 to 0.791 in relation

to the report's four subindexes: political empowerment, economic participation and opportunity, educational attainment, and health and survival (WEF, 2020). In other words, the report states a gender gap of 0.219 or 22%.

Rwanda therefore places highly overall because it is 4th when ranked by political empowerment thanks to the near equal number of women and men in parliament (WEF, 2020). Gender inequalities mainly emerge in latter levels of education, and particularly in economic opportunities. In addition, men in Rwanda have a higher literacy rate (77.6% compared to 69.4% of women) and are more likely to enrol in higher education than women (ratio of 1 to 0.81), despite the higher number of girls that enrol in education at secondary level. Rwanda's employment statistics further indicate that, for those women who do enrol in higher education, educational achievement does not necessarily translate into skilled employment. In sum, despite women and men participating equally in the labour force, almost twice as many men than women work in professional and technical roles, meaning income and wages for female workers are significantly lower (with a gender parity score for overall economic participation and opportunity for Rwanda of 0.672; WEF, 2020)

HE participation has increased across Africa over recent decades following policy interventions at state level (Barnes, 2007). Currently, the enrolment of girls in STEM, digital fluency and literacy, which has been low, is being boosted by various innovative initiatives, such as STEM awareness campaigns. As a result, the number of girls participating in these new emerging fields is currently estimated at 45.6% (GMO, 2019). However, access to university varies among African countries and is impacted by colonial legacies related to class, race, and gender, making it harder for certain groups to progress in their studies (Van Houweling, 2020). For example, as the WEF report demonstrates, women tend to earn less money than their male counterparts. Consequently, despite the greater flexibility private universities in Africa have shown towards students with work or childcare commitments, who are overwhelming female, the fees for such institutions put them beyond the reach of most women (FAWE, 2010). This perpetuates the gender divide seen in the number of women in professional and technical employment.

The African Academy of Sciences (AAS) report on women in STEM in Africa shows that, once in work, women's careers are hindered by caring and family responsibilities, gendered expectations of competence and commitment that favour men, and overt preference for male colleagues among other socio-cultural factors (Mukhwana et al., 2020). This brief overview highlights some of the intersecting barriers and challenges that women in STEM face in Rwanda. Although the country's high overall ranking shows that great progress had been made in the last two decades in relation to gender inequality and poverty reduction, these remain pressing priorities.

Gender and STEM in Indian HE and Employment

India ranks 112th overall with a gender parity score of 0.668 in the WEF gender gap report (WEF, 2020). India and Rwanda share certain commonalities in this report, such as a higher literacy rate for men (82.4% compared to 65.8% of women), whilst indicating slightly more girls than boys enrol in primary and secondary education (ratio of 1 to 1.07). Interestingly, unlike Rwanda, figures also indicate that more women than men enrol in HE. Yet, much like in the Rwandan case, these numbers do not appear to translate into skilled employment for Indian women. India's parity score for overall economic participation and opportunity has worsened from 2006, to 0.354 with more than double the number of men than women employed in professional and technical roles. (WEF, 2020)

The Indian government has made various policy commitments to combating gender disparity in STEM employment and education. The Science, Technology and Innovation Policy (Government of India, 2013) has made gender parity a goal by setting up flexible schemes that aim to facilitate women's careers in STEM fields. In terms of education, the country's National Education Policy 2020 (Government of India, 2020) includes a Gender-Inclusion fund to eliminate disparity in access to education more broadly based on gender or other socio-economic disadvantage. Despite these actions, India's National Policy for Women 2016 notes that gender-based violence has also increased over recent years (Government of India, 2016). Furthermore, the report finds that while more women have entered skilled employment in India, a significant majority are still in low paid, informal work, reflecting socio-economic or 'class-based' inequalities within the country (Belliappa, 2013). Once in employment, Indian women face barriers to their progression and continuation in STEM fields, such as expectations and pressures to make childbearing and family a priority over their careers (Subramanian, 2007; Gupta, 2012); an underestimation of women's skills and competence from employers; and a lack of opportunity to progress in terms of career advancement (Patel & Parmentier, 2005; Gupta, 2016). Much like in the Rwandan case, this national review reveals that despite efforts made at the state level, women in India face complex and intersectional challenges to studying and working in STEM.

Global Intersectional Inequalities for Women in STEM Beyond HE

As illustrated above, current research suggests that girls and women in India and Rwanda are less likely to 'take the next step' in their STEM journeys, whether that is enrolling into university STEM disciplines, or moving from graduation into STEM employment-highlighting these two key transition points as crucial for global focus on women's STEM attrition risks. Our project explores these crucial timepoints of the STEM education-career trajectory, focusing on key life moments, in other words exploring holistically exploring the gendered journeys of STEM students accessing university, using longitudinal mixed-methods

approaches to follow these journeys through their HE studies, and moving beyond into skilled employment (UNESCO, 2017). We are keen to avoid reproducing gender binaries in our research, so we will encourage our participants to self-identify as they see fit, with the categories 'female' and 'male' referring to individuals that identify as such. In addition, as we have stated, we are keen to avoid deficit models of gendered inequalities of STEM (or the so-called 'fix women' approach, seen in discourses of 'Lean-in' and 'Step-up'; see Dasgupta & Stout 2014 for review of interventions), with a social psychological focus of the person embedded within STEM structural barriers (Lewin, 1947; Allport, 1979), combined with a wider sociological lens that includes poststructuralist and transnational feminist perspectives (Mohanty, 1986; Butler, 1990, 1993; Grewal and Kaplan, 1994; hooks, 2015).

Our review of the literature to date has highlighted the many intersecting factors that impact on the choice to enrol and stay in STEM education, and to progress onto and stay in STEM employment. Furthermore, the COVID-19 pandemic has caused global upheaval, disrupting economies and working practices. While the long-term impact is yet to be known, in the short-term, the health crisis appears to have compounded gender, racial and wealth inequalities in our personal and professional lives in three key ways (Public Health England, 2020; Campbell & Tardit, 2020). Firstly, in the UK as elsewhere, the economic crisis that has accompanied the pandemic has seen significant job losses, in which those on temporary and precarious contracts in a variety of sectors are more likely to have lost their income (Batty, 2020). A report by the London School of Economics highlights that women and individuals from Black, Asian and minority ethnic backgrounds have been hit harder by earnings losses partly because they are more frequently employed on insecure contracts (Major et al., 2020).

Secondly, those in more secure employment who have been working remotely have had to deal with additional childcare responsibilities owing to the closure of schools due to the health crisis (Office for National Statistics, 2020). Women have generally taken on more of these familial responsibilities than their male partners or counterparts (Andrew et al., 2020). This has a gendered knock-on effect on career progression: for example, in STEM research, women have had less time and energy to spend writing articles and producing research outputs that are central to promotion and recognition in these fields (Shurchkov, 2020). Furthermore, LinkedIn data has shown that the hiring of women fell during the initial stages of the pandemic (Gentle, 2020), and women caring for children are more likely to face redundancy (Campbell & Tarbit, 2020). These general trends bolster rather than deconstruct existing divides in STEM, in which more women occupy junior and precarious positions (a trend repeated across disciplines), and are more at risk of leaving the field (Blackburn, 2017; Besselaar & Sandström, 2017).

The last compounding factor we consider here is the digital divide, which plays out both nationally and globally (Broom, 2020). In the UK, the media have reported on the lack of laptops and internet access available for children from lower income households (Ferguson & Savage, 2020). This risks aggravating well-established participation and attainment gaps in UK

HE on the basis of socio-economic background and ethnicity (Crawford & Greaves, 2015; Doku, 2019). Globally, the cost of internet access puts it beyond the reach of many households: for example, in Sub-Saharan Africa, "one gigabit (GB) of data - enough to stream a standard-definition film for one hour - costs nearly 40% of the average monthly wage" (Broom, 2020, paragraph 13). The digital divide is also gendered: in low and middle income countries, women and girls are less likely to own a mobile phone and use mobile data, due to financial pressures and a lack of written and digital literacy skills (ITU & UNESCO, 2019). This gap is widest in South Asia, where women are 28% less likely to own a mobile phone than men, and 57% less likely to access mobile data (ITU & UNESCO, 2019). The pandemic puts those struggling to access devices and the internet at an even greater disadvantage as the possibilities of face-to-face learning and networking are still not safe. These issues risk magnifying existing barriers to entry and progression in STEM in Rwanda, India and the UK, with women and girls' access to education further restricted and their professional opportunities further out of reach.

Gendered Journeys International Team

Our project team combines expertise from India, Rwanda and the UK. The team from India, based in the Indian Institute of Management (Calcutta), includes Professor Manish Thukar and Dr. Saikat Maitra. They have extensive expertise in education and skills, and public policy analysis. The team from the University of Rwanda includes Dr. Marie Chantal Cyulinyana, a Physics Lecturer and President of the Rwandan Association for Women In Science and Engineering (RAWISE), and Jane Umutoni, an Assistant Lecturer and Researcher in the Centre for Gender Studies. Jane has been involved in a range of projects at the University of Rwanda constructing gender-responsive pedagogical tools for schools and university teacher training; and was a co-investigator for the ESRC-funded Examining Gender in Higher Education network in 2017-18 led by Dr Barbara Read. The UK team, based at the University of Glasgow, includes Dr. Barbara Read (PI), Professor Catherine Lido, Dr. Srabani Maitra, Professor Bonnie Slade, Dr. Emma Seddon and Dr. Sumita Chatterjee. Overall, the team has strengths in qualitative and quantitative research, gender theory, workplace learning, higher education research and STEM. Kris Paisley and Julie Cooper provide administrative leadership on the project.

Gendered Journeys to Date

The next stages of the project will involve the three country teams working together to explore existing national secondary data, as well as primary data collection. We are taking a mixed-methods approach to enable the collection of a wide range of data from STEM students and graduates in India, Rwanda and the UK. We will carry out quantitative analysis of secondary data for the UK, and India and Rwanda to get a broader, aggregate picture of access, achievement, attrition in HE and entry into skilled employment for the two countries with the

UK offering further comparisons (given large-scale data available). Primary data collection due to start in the coming months will include a large-scale, primarily online, survey of STEM students distributed widely across India, Rwanda and the UK. The survey will gather information on detailed STEM study demographics as well as issues of belonging, peer support, student satisfaction and well-being as they relate to STEM achievement, attrition and onward career progression. This survey will be followed up one year later to explore the changing nature of STEM commitment and assess factors facilitating STEM engagement versus barriers to onward STEM progression, acknowledging there will be significant amounts of attrition between data collection points. The online survey will be followed by a phase of qualitative in-depth interviews with key stakeholders in India and Rwanda, such as local, national HE policymakers and relevant institutional HE practitioners, which will explore approaches to the research problem from institutional and organisational perspectives. This scoping exercise will feed into our design of the research instruments for interviews and focus groups with STEM students and graduates in India and Rwanda, which will focus on facilitators and barriers to progress throughout participants educational and career journeys. We will use existing secondary qualitative and mixed methods datasets on students in the UK available through the UK Data Archive for comparison purposes. The final phase of data collection will involving gathering social media data to explore chatter and networks that have formed on Twitter in relation to gender and minorities in STEM. In addition to academic papers, data collection and analysis will contribute to the production of an online 'toolkit' for universities across sub-Saharan Africa and Southern Asia who are interested in addressing the disparities in their STEM departments. This mixed-methods approach will offer a more holistic global view by triangulating large-scale data on STEM students and fine-grained qualitative data of the experiences of both students and graduates, with both secondary and primary data sources.

To date, COVID-19 has created challenges to our planned data collection, which included in-person interviews and classroom observation. We have had to develop alternative plans to proceed safely, including a shift to remote interviewing and focus groups – either online or over the phone – which presents its own ethical and methodological challenges. Moreover, the pandemic has impacted on our plans for knowledge exchange within the team. Our project was originally designed to include extended whole team meetings in each country where each team member would share knowledge and expertise in addition to co-designing research materials, taking active strides to make the project as equitable as possible. This would also have enabled each team to experience and share their own and each other's country contexts. Travel restrictions due to the pandemic has meant that such a collaboration has become limited to virtual meetings where the instability of internet connections has inevitably altered shared experiences.

However, these conditions have engendered a more collaborative approach to exploring novel methodologies, and has moved the survey work largely online- meaning we have had some fascinating cross-cultural exploration of how to capture concepts such as self-efficacy,

belonging and gendered stereotypes, as well as clear discourses around national demographics measuring gendered identity and sexual orientation. Had the original strategy moved forwards with countries relying on third party survey companies for face-to-face data collection, these conversations may not have emerged.

The greatest barrier currently facing our work, but also evidencing barriers facing early career women researching in STEM, are cuts to UKRI funding, which occurred unexpectedly and without contingency ('Academy responds to UKRI announcements on funding cuts', n.d.). The team continue to promote collaborative and inclusive partnerships within our international team, ensuring the Indian and Rwandan team members are prioritised for monetary support, as well as prioritised for research support with data collection and analysis.

It is only by keeping partnerships close, engaging with culturally embedded qualitative and quantitative practices with our Covid-adjustments that we can tap Covid-19 as an opportunity to explore the changing situation of STEM students and graduates, particularly the impact on women, as we have moved rapidly to online learning and working. This shift is showing worrying signs of increasing, rather than decreasing inequalities (Cebula et al., 2020; Cebula et al. 2021), making the Gendered Journeys project even more crucial in terms of identifying risk factors and solutions for women's attrition from STEM into HE and beyond into skilled employment, particularly in Rwandan and Indian, but ideally with lessons for global STEM inclusion.

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