Girls can do STEAM too - investigating the influence of a STEAM career awareness workshop on Tanzanian and Zimbabwean secondary school girls' perception of careers in STEAM

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ABSTRACT: The Joule Foundation (TJF) is a United States based non-profit organisation whose mission is to promote science, technology, engineering, arts and mathematics (STEAM) education among young African girls through academic programmes. Through STEAM career awareness workshops form III and IV, girls are invited to a virtual panel conversation with Joule Foundation's founders, TJF board members and a live-panel of female STEAM professionals from the young girls' own region. The young women also get an opportunity to work in teams and complete a simple problem solving task. All of the girls are invited to complete pre- and post-surveys and a few are invited to be interviewed about their STEAM experiences. In this article, the author shares findings from analysis of the survey data related to the girls' STEAM and non-STEAM career aspirations, challenges to pursuing STEAM related careers, and the lessons learned from participating in the workshop. In this article, the author presents results from the survey responses (n = 170) from the Tanzania and Zimbabwe workshop sites. Findings indicate that the career awareness workshop and panel is well received by the girls and gives them an opportunity to ask questions, expose misconceptions about women in STEAM career pathways, and begin to see themselves as future STEAM professionals.

Keywords: STEM, gender stereotypes, career guidance, informal learning, African girls

INTRODUCTION

Educational equity is a worldwide concern that is at the heart of the Joule Foundation's (TJF) mission [1]. Specifically, the focus of the organisation is to engage more African secondary school-aged girls in career and educational possibilities related to science, technology, engineering, arts and mathematics (STEAM). Much of the previous scholarship focused on science, technology, engineering and mathematics (STEM). For the purposes of this work and partnerships with local schools, the organisation includes art and design disciplines in addition to STEM. Thus, when discussing TJF, one will refer to STEAM and when referring to previous scholarship, one will reference STEM or the appropriate acronym.

Inequitable education and representation in STEM career and academic pathways is seen as a worldwide challenge and impacts girls and women in many different ways at different points on the career pathway. For example, in most countries girls report holding lower interest and STEM related self-confidence than boys in the same country. Eventually, this is demonstrated in the fact that women earn only 25% of STEM degrees in Organisation for Economic Co-operation and Development countries yet they represent 51% of the world's populations. Girls' perceptions of who can participate in STEM also negatively impacts participation in the field. Gender stereotypes and educational inequalities and disparities have caused a huge representation gaps and many young women to miss out on diverse STEM engagements opportunities [2]. STEM fields are missing out on talent, because women are not equally represented [3].

Worldwide political response to this disparity has led policy makers to call for ways to the educational gaps. UNESCO Institute of Statistics reports that girls are more likely than boys never to enter primary school and that 31 million girls are out of school around the world [4]. Sub-Saharan African nations have the highest rates of exclusion of the regions, UNESCO evaluates. By adolescence, 36% of girls are not in school. Across the continent of Africa girls' participation in STEM is typically governed by performance on national examinations.

In Tanzania, there have been calls for education reform with one of the priorities being improving access to education for young women. In a recent study, it was found that girls' performance in mathematics and science subjects trailed boys on national examinations after primary school [5]. Unfortunately, lower engagement of Tanzanian young women in STEM continues into higher education where participation is also low. In Zimbabwe, young women make up only 4.5%

of the country's population of students studying college-level science and in many cases the family believes it makes more sense to educate their boy children over their girl children [6][7]. Thus, in both Tanzania and Zimbabwe, girls are enrolled in science, mathematics, information and computer technology (SMICT) at lower rates than boys [7].

There are common challenges that face young African women who want to pursue advanced education and STEM academic pathways [2]. Unfortunately, the male dominated narratives of who is capable of studying and learning mathematics and sciences cause many girls to opt out of mathematics courses and mathematics related experiences [8].

Implicit gender stereotypes promote that boys perform better than girls in these disciplines and that girls are more adept to pursue home-oriented careers and related experiences. Girls who grow up in societies, which promote these narratives fall victim to stereotype threat, which suggests that these young women have begun to internalise this misconceptions about their ability. This is typical of stereotype threat [9]. These common narratives derived from misconceptions can also lead to mathematics anxiety and mathematics avoidance amongst girls [10]. This leads to researchers, educators and parents finding that some girls have low mathematics value and confidence.

In addition to internal resistance, girls also face external resistance - teachers and educators who also believe these stereotypes about their female students. Researchers have found the cultural socialisation causes parents and educators to groom boys to have a higher self-confidence in critical thinking and problem solving [11]. These are critical skills to apply to the sciences. These varying expectations and other societal factors ultimately result in a negative influence on engagement of girls in STEM later in life [12].

RESEARCH QUESTIONS

The research question, which guided this investigation was: *How do secondary school girls' perception, awareness, and aspirations of STEAM careers change after engaging in a STEAM career awareness workshop?* The following sub-questions further informed the study design:

1. What are the secondary school girls' perceptions of STEAM careers?
2. What are their aspirations?
3. What challenges do the girls identify to achieving their STEAM and non-STEAM goals?

METHODOLOGY

Research Design

The Joule Foundation is a United States based non-profit organisation whose mission is to promote science, technology, engineering, arts and mathematics (STEAM) education among young African girls through academic programmes [1]. The foundation designed interventions in the form of STEAM awareness workshops and STEAM content workshops to address these challenges. These interventions are informed by evidenced-based solutions to broaden the participation of girls in STEM pathways [13].

This study used a descriptive research approach and survey method to collect both qualitative and quantitative data [14-16]. The pre-workshop and post-workshop surveys were used to explore the girls STEAM conceptions, as well as the impact of the event on their STEAM career awareness and perception of engagement with STEAM.

A description of the workshop is important to the design of this study. There were two workshops - one at each of the schools in two separate countries. Workshops occurred within the same calendar year in the spring of 2018. The Joule Foundation worked with the headmistress of the schools via an onsite Joule Foundation representative (e.g. national director of engagement) who coordinated every component of the workshop at the school sites, while the board coordinated the overall workshops remotely.

Population

The population for this study consisted of one-hundred seventy ($n = 170$) secondary school-aged young women enrolled in all-girls boarding schools in Zimbabwe ($n_{Zimbabwe} = 88$) and Tanzania ($n_{Tanzania} = 82$). All of the girls who participated in the workshop participated in the pre- and post-surveys. In the following sections, participant information is disaggregated by site.

Tanzania site - Jangwani Secondary School is an all-girls high school located in the city of Dar-es-Salaam in Tanzania, East Africa. Jangwani is one of the oldest schools in Dar-es-Salaam. It accommodates both boarding students and those commute daily. Jangwani's academic focus is in the sciences with students specialising in STEAM subjects for the advanced level classes. The academic levels are split into two: ordinary level (O-level) and advanced level (A-level). Since Jangwani is a government school, students need to pass the seventh grade national examinations and get selected in order to attend.

Tanzania workshop - eighty-two form-III and form-IV students (O-levels last two years) attended the first workshop. These students ranged in ages 15-16 years old and represented diverse social and financial background. Some of the students came from English-medium primary schools, which are usually private schools and some come from Swahili-medium government schools. The workshop was conducted in English with some Swahili translation. The Joule Foundation board participated remotely via Web conferencing and a panel was held live with the girls. The panel included: a medical doctor, a computer scientist, an architect, an interior designer and a mathematics university professor.

Zimbabwe site - Girls High School Harare, was the first public school for girls founded in 1898 in Harare, Zimbabwe. The school is celebrating 120 year of providing education. The academic levels are split into two: ordinary level (O-level) and advanced level (A-level) for forms I-VI.

Zimbabwe workshop - eighty-eight students participated in this career awareness workshop. The objective of the workshop was to share and present the many possibilities of a STEAM education and careers, as well as connect the girls with positive role models in STEAM fields. Members of the Joule Foundation board participated remotely via Web conferencing and a panel was held live with the girls. The panel included: a computer scientist (animator), a medical doctor, a nutritionist, a process engineer and a systems analyst.

Data Collection

The data for this study was collected through the administration of a pre-post workshop survey instrument. All but one question on the instrument was open response. The pre-activity instrument was designed to get the young women's preliminary understanding of STEAM, career desires and perception of mathematics ability. The post-activity instruments questions were written to explore how their conceptions of STEAM career pathways were influenced by the workshop and their thoughts on a career pathways. Additionally, the post-workshop survey helped the foundation understand what information the young women received from the activity and gauged their interest in more STEAM relevant workshops.

Data Analysis

The data were both qualitative and quantitative types. Quantitative data were analysed using descriptive statistics. The open-response questions were thematically analysed using the NVIVO qualitative analysis software. The Tanzania and Zimbabwe data were analysed separately, and then later compared to identify similarities and differences in the young women's conceptions of STEAM career pathways, perception of their mathematics ability, and confidence/ awareness of their ability to contribute to and participate in STEAM disciplines.

Finally, the results of analysis were shared using the counter-storytelling theoretical approach. It is an appropriate theoretical approach to understanding the influence of a career awareness workshop on the awareness of STEAM career and STEAM aspirations for Tanzanian and Zimbabwean secondary school girls [17]. Through counter-story, scholars challenge dominant positioning of communities of colour, which may include …*layers of assumptions that persons in positions of racialised privilege bring with them to discussions of racism, sexism, classism, and other forms of subordination* [17].

Following this tradition, the author is mindful that assumptions of African education, culture and access to resources are abundant. Through this work and the results of the research, the author seeks to empower the participants through her presentation of their experiences and perceptions in the African educational context. In the findings section, the author shares excerpts from the participants. Through the expressions and results shared in this article, the author hopes to challenge deficiency narratives through careful analysis of survey responses and representation the girls' experiences.

FINDINGS

The findings are presented and include anonymised supporting excerpts. The subscript indicates if the response was given by a Tanzanian (T) or Zimbabwean (Z) girl. The research question, which guided the investigation was: *How do secondary school girls' perception, awareness and aspirations of STEAM careers change after engaging in a STEAM career awareness workshop?*

Table 1: Total correct and incorrect STEAM definitions by country.

	Correct STEAM	Correct STEM	Incorrect	Total
Tanzania	73	1	14	88
Zimbabwe	60	11	11	82
Total	133	12	25	170

What do you think STEAM stands for? - Across both samples 133 girls gave a correct answer, while 37 girls provided an incorrect answers. Correct responses were as follows: science, technology, engineering, art and design and mathematics; science, technology, engineering, art and mathematics. Examples of incorrect responses included: *science, technology, and educational association management; science, technology, education, art and mathematics; and science, technology, engineering and mathematics*. Of the incorrect responses, twelve (12) were the traditional STEM (science, technology, engineering and mathematics), with only one of those responses being from a Zimbabwe respondent.

Confidence in Mathematics and Science Ability

At the start of the workshop, all of the young women were asked to rate their confidence of their mathematics and science ability. The results are shown in Table 2, which reveal that 83% of Tanzanian girls and 85% of Zimbabwean girls rated their confidence in their mathematics ability as *good* or higher. There were five missing responses to this question. Total responses are reflected in Table 2.

Table 2: Participants' self-reported mathematics and science confidence by country.

Confidence in mathematics and science						
	Not good	Average	Good	Very good	Excellent	Total
Tanzania	1	13	32	27	11	84
Zimbabwe	0	12	36	26	7	81
Total	1	25	68	53	18	165

Career Aspirations

The young women were also asked to share their career aspirations. These are represented in Table 3. Their responses were categorised into seven STEAM and non-STEAM categories. Responses to the career interest question were not mutually exclusive. Therefore, the total responses are greater than the sample size as some participants listed multiple career interests.

Table 3 Participants' career interest by country.

Career interest								
	Arts (non- STEAM)	Business	Education	Government	Medicine and human services	STEAM	Unknown	Total
Tanzania	5	2	0	0	52	32	3	94
Zimbabwe	5	1	1	1	44	32	1	85
Total	10	3	1	1	96	64	4	179

The two categories of career interests that had the most responses were *STEAM* and *Medicine and human services*. The STEAM career interests included the following career categories: engineering (43); pilot and machinery (14); computer science (3); food science (2); anthropology (1); and actuary science (1). Forty-eight (48) girls ($n_{Tanzania} = 34$, $n_{Zimbabwe} = 14$) responded that they had career interests in medicine and human services. Other medical professions across both sites included careers, such as surgeons; gynaecologists; paediatricians and psychologists. In addition to STEAM, and medicine and human services, a few of the girls were interested in pursuing careers in non-STEAM art and design, such as fashion design; in business with their aspirations to be multimillionaire business women (with no descriptors of the type or form of business); in education; and in becoming a spy (government). Four girls were unsure of their career interest.

Workshop Expectations and Lessons Learned

Presented here are the results from the young women's responses to questions related to their expectations for the workshop, lessons learned from participating in the workshop, and how they may modify their actions, behaviours and plans as a result of participating in this workshop. Overall, the girls' workshop expectations were met and their responses indicate increased inspiration to pursue traditionally male dominated fields and decisions to be more diligent in achieving their career goals.

The participants' before workshop expectations were coded and six categories emerged: career guidance (52); developing a success mind-set (24); general skill development (20); inspiration (6); understanding STEAM (98); and the Joule Foundation (3). The numbers in parenthesis represent the number of unique comments that could be coded within that category. The workshop attendees may have had multiple expectations that fell within several categories of expectations. Therefore, the total responses are greater than the number of young women in the sample. Figure 1

demonstrates the pre-workshop expectations mapped to the post-event lessons learned. These were used as themes during analysis.

Before workshop expectation themes (B)	After workshop lessons learned (A)
(B1) Career guidance	(A1) Career selection and awareness
(B2) Developing a success mind-set	(A2) Disbelieve negative stereotypes
(B3) General skill development	(A3) General strategies for success
(B4) Inspiration	(A4) Inspiration
(B5) What is STEAM?	(A5) STEAM application, opportunities and challenges
(B6) Learn about the Joule Foundation	(A6) TJF impact on confidence in STEAM

Figure 1: Workshop expectations: before (B) and lessons learned after (A).

Pre-workshop Survey Results

The career guidance category (B1) contains participant responses, which reflected expectations related to gaining information about the career pathways available to African girls in STEAM and non-STEAM sectors. This category provided qualitative insights into how the girls perceived careers accessibility. It was apparent from the data that the girls are very interested in learning how to make career decisions and how to determine what career is a right fit for them. As was reflected in their career interests, the girls expressed hopes to get career guidance in STEAM and non-STEAM careers.

I hope to learn] how to do my science subjects the best way and to discover more career options - Nyasha$_{(Z)}$.

This excerpt represents the types of responses that were coded as general career guidance. Some of the participants also shared more STEAM career guidance specific workshop expectations. There were twenty-four (24) references coded for STEAM specific career guidance expectations. For example, *I hope to learn on [the] importance of studying science subjects and also careers through studying science* - Tatenda$_{(Z)}$. This response suggests that she may see a value proposition from studying science, and pursuing and excelling in science careers. To this point Evelyn$_{(Z)}$ responded, *I hope to find and to learn my future steps to my dream of becoming a ground breaking software and aerospace engineer.* Other participants also responded with hopes that will advance their dreams, even suggesting that there might be some relationship between science careers and addressing challenges that their respective countries are facing. There were six coded references to expectations that the workshop would help to align their career with their skills and abilities, *I hope to know what career will suit my marks in math and science*- Tumaini$_{(T)}$.

Finally with respect to careers guidance and expectations for the workshop, there were responses related to gender and career selection. Such as Tafadzwa$_{(Z)}$ who responded that she hoped *…to know the different engineering fields which are at my disposal as a girl child.* This response revealed underlying questions, assumptions or false ideas that the girls had about how women can engage in STEAM careers and academics. Though only two responses were coded in the pre-workshop survey, the post-workshop responses provided evidence that many more young women also were aware of negative assumptions about their participation in STEAM career pathways.

The girls also discussed developing a successful mind-set (B2). Their pre-workshop responses were thematically sub-coded into expectations related to 1) developing the successful mind-set; 2) how to experience success in the STEAM field and STEAM related academics; and 3) how to develop a successful mind-set as a girl in society. For example, *I am going to learn how to be a real scientist and have a great mind-set as a girl child* - Amina$_{(T)}$. This response indicates both a desire to pursue a STEAM career and an awareness of the role that being a *girl child* can have on a successful mind-set.

There were twenty (20) references coded as general skill development (B3). The girls described their anticipation of learning specific skills. Sixteen of the twenty references related to a skill that would lead to non-STEAM specific personal development or advancement. The girls often referred to ambitions or goals that they hoped to learn how to achieve. For example, Asha $_{(T)}$ *I hope to learn how I can stand for my ambitions and how I can fulfil to reach my career and be aware of it.* Shamiso $_{(Z)}$ expressed, *[I hope to learn] whether what I am doing in terms of effort and preparation is enough for me to reach my ultimate goals.* Decision making, creativity, design and non-specific skills each were coded once across the data set.

Girls also hoped to gain inspiration to improve themselves, improve their self-confidence and to achieve their dreams (B4). Beatrice$_{(T)}$ responded that she hoped to learn *…how the youth can be empowered to engage in STEAM.* Within these responses, the girls also expressed a desire to learn how to be girls who achieve their goals, prepare for their future and engage in science.

A majority (93) of the coded pre-workshop expectations references related to anticipation of learning about STEAM (B5). In this theme, there were five subcategories. The girls hoped to learn about mathematics, science and engineering

career pathways and academics. Additionally, they hoped to learn about the importance of STEAM, what STEAM specific skills were and how to apply STEAM to solve problems.

Post-workshop Survey Results

Twenty-five (25) references indicated that the pre-workshop expectation to learn about career guidance was met during the workshop (A1). The participants reported learning the importance of being passionate about their careers, and of having a career goal and focus. Girls also commented that their awareness of multiple career paths increased, and they learned how to choose a career based on skills and interest. The girls' responses demonstrate that they are more aware of career options available to them. Furthermore, they learned that they can excel in their career if they set goals, have passion for their work and focus on meeting those goals.

> *Today I learned about how to build my future idea where I can apply it together with what I should do. So as to get the success I want to become* - Irene$_{(T)}$.

Regardless of their career choice, the girls' responses demonstrated an emphasis on have a mind-set that leads to success (A2). Responses were aligned with two themes: disbelieving negative stereotypes (83) and general strategies for success (51). The intersection of gender and STEAM careers and academics was the basis for responses related to stereotypes. There were 56 references that indicated that participants were empowered to believe that *girls can do STEAM too.* In addition to this empowerment, twenty responses reflected that the girls will reject future negative stereotypes about the participation of girls and women in STEAM academics and career pathways. In addition to STEAM pathways, there were 15 references to general female career empowerment. In these references, the participants expressed that *girls can do anything!*

Two participants indicated that they learned balance between home responsibilities and a STEAM career pathway. On the other hand, it was still apparent from a few responses that some young women believed that gender determines available career pathways. Two additional responses indicated that the participants perceived that women design better than men, and therefore STEAM was a viable career pathway for them. Finally, some girls commented that development a success mind-set was also dependent upon having male and female mentors. Their responses indicated anticipation about learning a success mind-set. Meeting their expectation to learn how to have a success mind-set seemed dependent on the panellists addressing negative stereotypes related to gender and STEAM participation.

> *I should be confident in what I do and love it. That I should not base what I become on false facts that people implement especially on women and girls* - Shamiso$_{(Z)}$.

Developing the success mind-set is also related to developing strategies for success (A3). The participants commented that learning never ends and they must learn how to take steps toward meeting goals. From forty-five (45) references, the girls specifically identified seven strategies for success that they learned from the workshop: ask questions, have high self-confidence, do not give up, have a positive achievement mind-set, have a passion for the science field, set goals and try new things.

> *We ladies break the limits more than even men and [we must] be confident in whatever [we] do*- Maimuna$_{(T)}$.

There were ten references, which indicated that the girls ended the workshop inspired to achieve their STEAM and non-STEAM goals (A4).

> *I have been encouraged to continue with my science subject course now I know I can do it… I will try hard with all my efforts* - Koku$_{(T)}$.

The primary objective of the workshop was to expose the girls to STEAM and relevant career pathways (A5). At the start of the workshop, a majority of the girls expected to learn about what STEAM is. The end of workshop survey responses indicated that the girls learned about the opportunities and challenges along STEAM career pathways and they learn about various STEAM applications. At a high level, the girls learned that pursuing STEAM career requires hard work and a focus on academics, which can impact their overall academic success. Therefore, they realised that by choosing not to neglect STEAM coursework, there were many opportunities that could be available to them in the future. In addition to their increased awareness of the career potential of STEAM, the young women also acknowledged learning about diverse applications of STEAM knowledge and skills.

> *I learned that the science - technology field is fascinating…* - Evelyn$_{(Z)}$.

The girls also expected to learn about the Joule Foundation and what to expect from the organisations engagement with their school (A6). The coded references indicated that girls learned more about the organisation and almost all of the girls indicated that they would want more STEAM programming in the future.

> *The Joule Foundation is all about educating the girl child* - Chipo$_{(Z)}$.

The girls reflected on how their experiences in the workshop may have changed their perspectives or outlook on their future goals. However, this data was only collected from the Tanzania site. The Foundation modified the survey before the Zimbabwe workshop. The participants from the Zimbabwe site discussed career interest changes and behaviour changes as a result of participating in the workshop. Sixty girls responded that they would not change their career interest from their previously recorded interest. For example, Afiya$_{(T)}$ responded, *I will change my way of studying, I will put more force in my interested subject. I would like to be a doctor when I grow up.*

Nine participants changed their career interest to a STEAM career after the workshop. After reporting that Dalila$_{(T)}$ wanted to pursue a career as a medical doctor at the end of the workshop, she had the following response, *I want to be an engineer.*

The girls also discussed diverse ways that their behaviour or actions would change as a result of applying lessons learned from the workshop. For example, Hiari$_{(T)}$ discussed how she will continue to pursue an engineering career and adjust her study approach to achieve her goals.

> *First, I will work hard and be more selective with the company I've so that I can achieve my dreams of becoming an engineer also I will inspire other young girls to involve themselves in STEAM* - Hiari$_{(T)}$.

There were 21 coded instances of reported planned change of behaviour. The following examples provide instances of the girls' plans to change their behaviour:

> *I will be more engaged in STEAM and study harder but my dream still is to be an astronaut* - Beatrice$_{(T)}$.

> *In my life I am going to change bad mind that boys are more capable to STEM than females, my dream is to be an architect* - Fatima$_{(T)}$.

Based on their pre-workshop expectations and the themes of their qualitative responses in the post workshop survey, the Joule Foundation met the expectations of the girls (A6). Upon further analysis, it was apparent that in some ways, the workshops exceeded the girls' expectations. Many girls responded that they were inspired to pursue careers and excel in normatively boy fields like STEAM, and to find ways to tell other girls about it. Girls were also inspired to continue to pursue their previously stated STEAM goals, and to make academic changes in order to reach their personal and professional aspirations.

DISCUSSION

In this study, the author investigated the influence of two STEAM career awareness workshops on Tanzanian and Zimbabwean secondary school girls' perceptions of STEAM career pathways and opportunities. The findings revealed that a majority of the girls have a correct understanding of what the acronym STEAM represents. One might expect that most of the girls may become familiar with STEM over STEAM. The inclusion of arts *A* is relatively new; however, because of recent teacher professional development, it has been more readily recognised by the students. Nevertheless, for some girls *arts* was a new component of the traditional STEM acronym. In general, the girls rated themselves as either good or very good in mathematics and science. Although they had heard and learned negative stereotypes about women and mathematics and science, the girls in these workshops still expressed having confidence in their abilities. This is indicated by their mathematics and science confidence rating and their majority STEAM career interests. A majority of the girls indicated desires to work in STEAM or medicine related fields.

With respect to perception of STEAM careers, a majority of the girls already had STEAM career interests. Thus, the career awareness workshop ultimately inspired them to continue along their stated career paths. Additionally, they were motivated to modify specific behaviours, attitudes and activities in order to achieve their goals. The workshop reinforced STEAM career aspirations. Of the girls that had non-STEAM career aspirations few indicated a desire to change yet they still were inspired to achieve their goals. This was unexpected yet encouraging given that in most literature the educational inequities yielding lower interest, confidence and STEM engagement is more prevalent than research presenting African girls with high interest and higher mathematics and science confidence. There is opportunity to impact these girls' career choices through this workshop and exposure to potential role models. Research supports that these forms of informal STEAM learning activities can impact short-term and long-term goals and choices [18].

A major finding from this work is the impact of this workshop on the girls' perception of how they engage with STEAM course work and career pathways. It appeared that in general, the girls had a high self-confidence in their abilities and desires to pursue STEAM careers. However, initially only a few girls discussed the negative societal perceptions of them pursuing these careers. By the end of the workshop, the girls' awareness of the need to identify the stereotype and to reject and challenge it was more apparent and emerged in many responses. This is a prime example of the influence of counter-storytelling. The application of this theory through the panellists' narratives brilliantly empowered the girls to resist, challenge and overcome stereotypical perspectives [17].

It is possible that because of the open dialogue from the panellists about the challenges, they experienced in their STEAM careers and their experiences overcoming these challenges created an environment that allowed the girls to be comfortable 1) acknowledging that the stereotype and negative associations exist; and 2) discussing feelings of empowerment to reject those associations. Studies have shown that interaction with role models can impact academic performance and help to counter negative stereotypes [18].

This is significant, because the girls from the Zimbabwe site expressed a desire to change their mind-set, behaviours or attitudes about themselves and their ability to achieve their goals. In fact, research supports that when a growth mind-set is encouraged - i.e. demonstrate that mind-set can be changed by providing strategies to help meet goals and improve self confidence in this study - helps to strengthen girls' confidence in their mathematics and science abilities [20-22]. They appeared to have a more empowered mind-set after one workshop with virtual and in-person panellists. It is also possible that the girls were able to see themselves in the experiences of the panellists, and thus they were able to identify with their lived experiences [21].

STUDY LIMITATIONS

The author acknowledges the limitations of this study. One of the most impactful limitations is the design of the interventions and consistency of the survey instrument items. The main purpose of the intervention remained the same across both sites; however, it was impossible to have the same speakers present at both secondary schools in two separate countries. Both sets of panellists represented the diversity of STEAM career pathways well, but they also presented unique experiences. Therefore, the girls at both sites received the same overall message, but did not get the exact information as the girls at the other site. This could have potentially impacted the participants' post-workshop responses.

Another limitation is that the participants completed a slightly different survey instrument at each site. The sponsoring organisation modified the survey between workshops, so the research team was unable to compare responses across the two sites for one survey item. Findings related to that question can only be applied to participants from the corresponding site.

FUTURE WORK

These findings from the workshops can inform the design of future work. Future research should investigate the long-term impact of these workshops on the participants' academic, testing performance and career choices. In addition to collecting survey data, a recommended future study should include interviews to follow-up on the survey responses and explore the individual participants' unique experiences and perspectives. In future work, the research team can also disaggregate the qualitative responses by site to explore more granular differences between the groups.

CONCLUSIONS

Girls in African countries benefit from experiences, which reinforce their mathematics and science abilities and aspirations, and allow for counter-stories to be shared openly. This is significant, because they often learn competing narratives about how men and women should engage in the STEAM career pathways. The common narrative diminishes or even excludes women from pursuing advanced education let alone pursuing STEAM careers.

These workshops were successful in meeting the Joule Foundation's objectives and the participants were empowered to continue on their career paths of choice. The girls met women in STEAM and were able to connect to their experiences, reject misconceptions about girls participating in STEAM and learn from the panellists in order to advance their own goals. The Joule Foundation's motto is:

Give her a change, let her achieve.

The findings of this research support this vision and demonstrate that African young women benefit when they have an opportunity to learn from those who have trail blazed ahead of them.

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BIOGRAPHY

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