Understanding the Factors Influencing Women's Career Trajectories in STEM Education in Kazakhstan

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Abstract: Although female researchers in Kazakhstan account for 53% of the total, those engaged in science, engineering, and technology fields (STEM) account for less than 45% of the STEM total. A similar pattern is experienced with respect to tertiary education students in Kazakhstan with the percentage of undergraduate women being 58% of the total, but only 32% of the undergraduate students in STEM. Thus, the phenomenon of "leakage" from the STEM educational pipeline starts early and persists, albeit ameliorated with advanced degrees. This study seeks to identify the barriers that deter Kazakhstani women from entering STEM disciplines, from persisting through their studies, and from pursuing successful academic careers. Specifically, the purpose of this study is to identify the extent to which various socioeconomic and institutional factors shape the perception of women towards STEM fields. The major methodological instrument employed is a set of qualitative interviews of female faculty in STEM, designed and calibrated for the local context. The interviewees were randomly selected from one of the largest local universities with a broad spectrum of STEM disciplines. The proportion of indigenous female faculty members in STEM disciplines in this university is less than 25%. The preliminary results reveal that the key barriers are disrupted work-life balance, cultural stereotypes, poor self-assessment, and gender-based discrimination on an institutional level. In addition, factors such as availability of research facilities, job autonomy, involvement in decision-making procedures, and encouragement from the institution emerge as critical facilitators for effective female careers in STEM. The conclusions of this study are expected to inform the development of appropriate questionnaire instruments towards a larger study across a section of tertiary education institutions in Kazakhstan.

Keywords: STEM career, Kazakhstan, cultural stereotypes, gender gap, female faculty

1. Theoretical framework

The issue of female departure from STEM fields, commonly known as a "Leaky STEM pipeline", has been a topic of a massive concern in academia. Gumpertz et al. (2017) measured the likelihood of STEM female faculty departure and indicated that those faculty involved in teaching engineering disciplines are more exposed to a risk of leaving, particularly in between years of three to six. Even though the share of female researchers in Kazakhstan is an overwhelming 53% of the total research workforce, those engaged in engineering and technology account for only 45% of the total in STEM (UNESCO, 2020).

The local authority in Kazakhstan started implementing a concept of family and general policy aimed at fostering gender parity in various economic and social fields in 2017 (OECD, 2017). However, the issue of the STEM-oriented female researchers outflow remains neglected so far. According to the national statistical bureau, the percentage of female researchers with Master's degree involved in Engineering research and development makes up impressive 52% in 2021 (StatGov, 2021). Unfortunately, this number is profoundly smaller for those who pursue PhD and hold Doctor of Science degree with 40% and 17% respectively (StatGov, 2021). This confirms the theory of the "Leaky STEM pipeline" present in Kazakhstani academia among the females' researchers.

Numerous studies have been conducted internationally aiming to identify the factors leading to underrepresentation of female faculty in academia, covering a broad range of institutional and socio-economic issues (Christensen, 2018). While most of the research literature is patently is West-oriented, the research team tried to locate similar studies conducted in countries with a geographic and cultural proximity to Kazakhstan,

but only two such studies were located. The factors identified in the reviewed literature are broadly the following.

Workplace collegiality

Lack of professional networks between female and male faculty is recognized as one of the reasons for the female faculty outflow (Casad et al, 2021; Pascale, 2018). Xu and Martin (2011) examined the effect of an informal professional network in academia and found that women faculty are affected by imbalanced male-dominated professional networks or lack of these networks at all (Hart, 2016). Considering this phenomenon in a more granular way, the authors indicate that it occurs due to the unwillingness of male faculty to recognize female colleagues as an equal member of that community by stressing out her "minority" status (Xu and Martin, 2011).

Workplace climate

The effect of critical mass, or lack of gender diversity on institutional level was identified as another significant factor among STEM faculty. The evidence suggests that the lower the percentage of female faculty present within a department, the more likely the female faculty is disproportionally assigned to undergraduate teaching (Hart, 2016), thus spending less time on that of a graduate level, research activities or leadership positions (Carrigan et al, 2011). This reportedly results in a lower job satisfaction and reduced chances of obtaining career advancement with a higher compensation (Christensen, 2018). The higher involvement of the female faculty in decision-making committees and processes turned out to have a positive impact on the retention rate as well (Taylor et al, 2017).

Job resources and support

Female STEM faculty with a greater job autonomy, job resources and time to conduct research are more inclined to stay at their current institution. Similarly, satisfaction with job compensation, job benefits, and job security turned out to have a direct impact on the intentions of STEM faculty to leave (Christensen, 2018; Pascale, 2018). The positive effect of mentorship, training, and workshops for pre-tenured female professors was justified by the observation that female turnover rate declined by 3% in departments in which a national policy to increase STEM faculty retention rate had been implemented (Taylor et al, 2017).

Career perspectives

One study (Kaminski and Geisler, 2012) discovers that the average number of years for female scholars to achieve tenure, full professor position, is estimated to be 11, but more than half of them end up departing and not reaching this point. Gumpertz et al. (2017) suggest that this departure rate is due to a longer period for a tenure-track female scholar to progress to an associate rank professor as opposed to their male counterparts. Moreover, faculty beliefs that their performance evaluation by supervisors is not based strictly on merit are strongly correlated with the desire to leave (Lawrence et al, 2014).

Family obligations

Christensen (2018) emphasizes increased stress level of female faculty caused by household responsibilities, specifically childcare, resulted in lower job satisfaction and intensifies the intention to leave. A similar pattern was observed in one of Russian university with female faculty admitting that household chores are barrier towards career progression (Didenko et al, 2019). Kuvaeva (2019) investigated this problem comprehensively with case studies at two other Russian universities, finding that female faculty experience a heavier burden than their partners to achieve work-family balance. Prioritizing first, and feeling more responsible for, family chores deprived them from allotting enough time on research, a critical factor for promotion and retention.

Often a flexible, personalized paid parental leave policy is proposed as a remedy and the effect of restricted or unclear access to it through open web sources is evaluated by Schimpf, Santiago and Pawley (2012). Qualitative interviews with female faculty indicate that information deficiency and unclear procedures cause unawareness, whereas adopting flexible, personalized parental leave policies may intensify rising conflicts within the department. As Kazakhstani legislation has relatively flexible maternity leave terms (one year partly paid and

three years unpaid leave), the recruitment of women upon return remains to be another subject for consideration. Contrary to preliminary assumptions, Williams and Ceci (2015) revealed that males in hiring committees still preferred women who took one year maternity leave over those who did not. Whether this flexible approach can be implemented in Kazakhstan remains an open question.

From literature review, it appears that (i) workplace collegiality; (ii) organizational climate; (iii) job resources and support; (iv) career perspectives; and (v) family obligations are primarily responsible for the gender gap in academia within STEM disciplines.

The general objective of this study is to identify the barriers that deter Kazakhstani female faculty to remain within their academic careers in STEM fields. Specifically, this study aims to firstly identify whether the described factors similarly affect the decisions of the local female faculty to retain in STEM academia. Secondly, due to differences in culture and mindset between Western and Asian nations, other potential factors inherent to the local circumstances will be explored. While this is an exploratory study and may not have hermeneutic power over the issues involved, it can serve to identify the range of factors that should be included as potential resolvents in the analysis to follow.

In this context, the following two hypotheses are suggested to reinforce the proposed objective of this study:

- The retention rate of females in STEM fields in higher education in Kazakhstan is similarly influenced by the factors listed in the international framework.
- There are other exclusive factors which are specifically inherent to the Kazakhstani higher education context.

This paper is organized as follows. In Section 2, the methodological steps guiding through this study are described. In Section 3, the relevant findings are derived and synthesized. Finally, Section 4 and Section 5 draw the conclusions along with the limitations and research recommendations.

2. Methodology

The female faculty underrepresentation in STEM disciplines in Kazakhstan has not been broadly examined. To investigate the barriers hampering the development of the female STEM faculty, the qualitative research of structured interviews was selected for this study. This method is particularly suitable in addressing issues with insufficient present knowledge on social and cultural contexts because the interviews provide a distinct opportunity to obtain a more comprehensive understanding of a respondent's beliefs (Mousa, 2021). The interviews provided us with a rich milieu of information to inform the development of a more refined questionnaire. At the same time piloting for interviews illuminated the interview team with the issues involved.

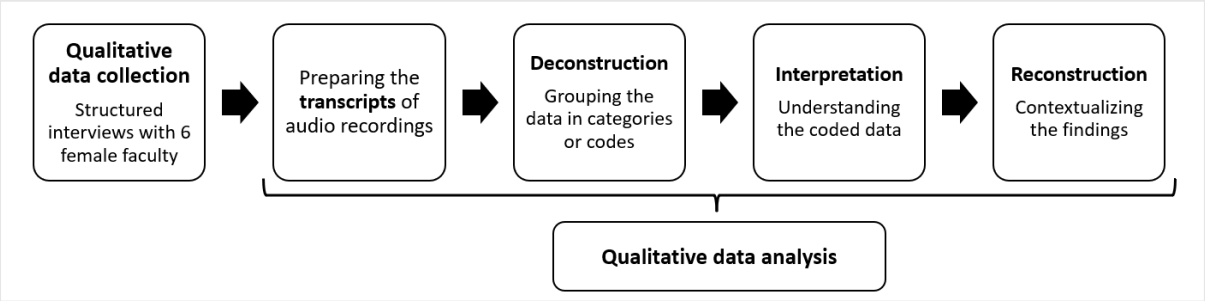

Figure 1: The flowchart of the methodological steps

The interviews allow to shed light on implicit patterns, which could be otherwise omitted through a process of survey. The derived findings from the interviews could subsequently serve as a basis for designing the survey, which will potentially embrace a larger audience and manifest the discussed issue holistically (Ertl, 2017; Tandrayen-Ragoobur and Gokulsing, 2021). The sequential steps guiding through this study are depicted below.

2.1 Qualitative data collection

The choice of female faculty as the interviewees in this study is aligned with Feminist Standpoint Theory, which implies that investigating inequality matters involves focusing on sympathy to those who are oppressed and have no advantage granted by the system (Barthelemy et al, 2016). Therefore, to exhaustively comprehend the

factors affecting women's decision to pursue STEM pathways, their individual perception should be examined inclusively.

Method justification

There are approximately 150 universities in Kazakhstan. However, only four of them offer a full spectrum of STEM disciplines and are listed in the global university ranking lists. Female faculty of these institutions represent the target population of this study. Before running large-scale research, it was decided to test the structured interviews on a selected group of respondents from one of these universities. The pilot study had three aims: (i) to gather data to provide guidance for a substantive study, (ii) to evaluate the data collection and analysis methods; and (iii) estimate the time required for the project. We argue that our methodological findings may contribute to a greater awareness of the important role that a pilot study may have for full-scale qualitative research projects. This argument assumes that researchers, especially novice ones, having conducted a pilot study will be better informed and prepared to face the challenges that are likely to arise in substantive study and more confident in the instruments to be used for data collection. The researchers also can enhance the skills necessary before commencing larger study. By conducting a pilot study, the researcher can obtain preliminary data, evaluate their data-analysis method, and clarify the financial and human resources required.

Sampling data and procedures

The research team performed six structured online research interviews lasting from 30 to 40 minutes each, approved by the Institutional Research Ethics Committee (IREC). Median years of participants' career experience was five years. The participants in this study were asked five demographic and seven qualitative questions. Qualitative questions were aimed at exploring female faculty's teaching load, research workload, job resources, department's climate, job autonomy and work life balance. These factors were recognized as the most ubiquitous ones concerning the female faculty based on the literature investigating a similar domain. Interview participants were recruited by a unique corporate email, were informed on the purpose of the study and only after receiving their written consent, an online interview was initiated. Online structured interviews via Zoom were arranged by the research team each of whom received specific training and certification issued by CITI program. To protect the identities of the respondents, each of them was provided a post-interview confidentiality form, allowing them to specify pieces of data that should remain confidential.

2.2 Qualitative data analysis

Qualitative interviews are often used to investigate people's subjective experiences and to understand their opinions and beliefs. The research team followed an inductive approach to the qualitative analysis aiming at locating common patterns across the observed interviews.

This section starts with the transcript preparation firstly and then follows interpretive analysis which includes three stages, namely deconstruction, interpretation, and reconstruction of the findings (Sargeant, 2012).

Transcript preparation

Having conducted five interviews, the research team transcribed all of them in a text format, ultimately converting around 205 minutes of audio files. The final transcripts were analyzed by two members of the research team of distinct gender to avoid possibility of a subjective bias.

Deconstruction, Interpretation and Reconstruction of findings

Each of the two researchers processed interviews individually and exhaustively labeled relevant words, phrases and sentences that were linked with the proposed hypotheses. The highlighted information was then grouped to form categories or codes, which marks the completion of the deconstruction stage of the qualitative data analysis (Watling and Lingard, 2012).

At the interpretation stage, each transcript was processed to locate the matching data to the formed categories. During this phase, the findings which embrace both commonalities and distinctions belonging to one categorized group were synthesized from all the transcribed interviews (Ramani and Mann, 2016).

The reconstruction phase refers to prioritizing the categories based on the corresponding frequencies of the findings appeared in the interpretation stage. This approach allowed to derive central insights around which sub-themes are built. These insights in turn were framed within and explained the existing theories and evidence based on the previously knowledge generated studies (Creswell and Creswell, 2017).

3. Research findings

After the interviews are complete, the results are analyzed to recognize patterns and gather insights.

The objective of this article is to highlight the importance of such a pilot, the lessons learned throughout the pilot process and the resultant improvisations to the major study of understanding the factors influencing women's career trajectories in STEM education in Kazakhstan. Considering the implicit sensitivities (professional and cultural) in such qualitative interviews, the outcomes of this pilot study are twofold:

- Define the criteria for selecting potential participants within the context of an appropriately representative sample; and to
- Improving the interview guide and the interview questions.

Throughout the interview, several factors hampering participants' continuity in STEM pathways are identified which are discussed below:

Workplace climate

There is a substantial imbalance in the number of female and male faculty in every discipline in favor of men (see Figure 2). Interviewee #1 stressed this issue by the dominance of male faculty in every position ranging from research-related positions to the administrative ones:

> *«Even if you look at all our leadership, we have only one woman, who oversees the training department. The research positions are occupied by all men, all committee members are men, even the department chairs are all men»*

However, any commitment to diversify the campus environment towards gender parity does not seem to be present at this stage, pointing out that the current situation as it should be. The critical effect of gender diversity absence on institutional level was also emphasized in the foreign literature (Carrigan et al, 2011) thus validating the theory of factors similarity to the international context.

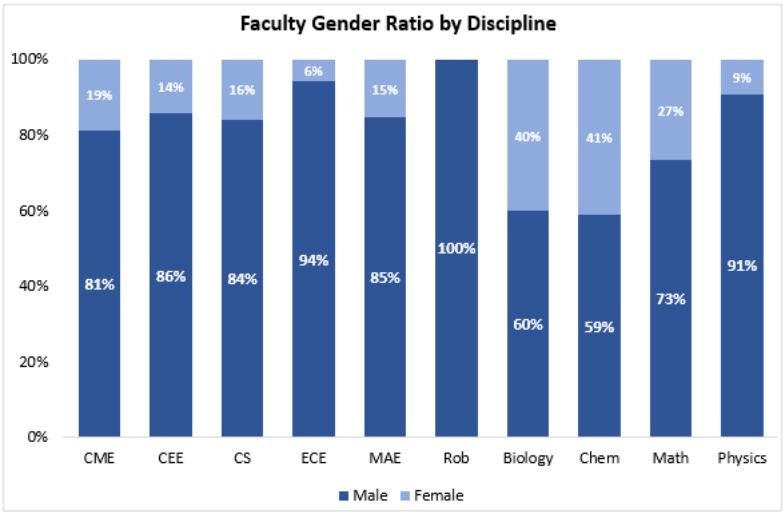

Figure 2: Faculty Gender Ratio by Discipline (CME-Chemical and Materials Engineering, CEE-Civil and Environmental Engineering, CS-Computer Science, ECE-Electrical and Computer Engineering, MAE-Mechanical and Aerospace Engineering, Rob-Robotics)

Moreover, the workplace climate was characterized as *not inclusive*. Commonly, there seems to be absence of transparency in decision-making processes. As a supporting argument, Interviewee #2 mentioned the following:

> *«As a beginner you do not get involved in anything, because other colleagues take everything for themselves»*

She also pointed out that the reason for such behaviour could be the gender as well as the nationality, age, or work experience. Also, it was observed that the female faculty find it difficult to speak up and express their objections, which forces them to convey message through third parties to a higher authority. Most respondents' answers were the same in the way that they are not permitted to take parts in the departmental meetings, especially when it comes to certain decision-making processes:

> *«I usually express my objections through the Professor with whom I used to work together»*
>
> *«All major and departmental procedures are done outside of the department»*
>
> *«The head of department just records videos and tells us what to do. He has also personal committee members, whom I don't know, and they can also take part in making decisions»*

Workplace collegiality

The natural division and lack of informal collegiality between female and male faculty are other points mentioned by several participants, pointing out that the female is viewed as somewhat "different" while entering an informal community consisting of mostly men:

> *«Men might hangout together and discuss some meaningful topics between each other, but once women try to enter the chat, they are regarded as a someone different, as a stranger»*

As for the research environment, it was observed that there is not much collaboration and interaction between the female faculty with the male counterparts within or across the departments too. Female faculty find it harder to integrate themselves with the existing research group led by male faculty. The lack of professional networks between male and female was also observed as a barrier for women in STEM by foreign researchers (Hart, 2016; Pascale, 2018; Pedersen & Minnotte, 2017).

Reportedly, due to the presence of discriminative views, women are obliged to perform beyond expectations to show that they are worthy:

> *«It takes a lot of effort to prove to male colleagues that you're not looser. We have the same degrees, the same regalia, the same publications... why do I have to prove it?»*

Family-related obligations

The participants with children responded that sometimes it becomes very challenging to find a balance between work and life, especially when the children were at the stage of innate babies:

> *«I didn't understand why women leave STEM until I finished PhD, got married and had a baby. You fall out for three years and can no longer work as hard as your male counterparts do»*

Interviewee #3 expressed her concerns regarding job performance indicators, primarily stressing out research workload, which is difficult to maintain during maternity leave due to family-related duties:

> *«When I gave a birth to my baby, I became less competitive in terms of research activities to obtain a tenure compared to those postdocs who were free»*

The back-integration after maternity leave is also complicated as reported by one female faculty:

> *«There was a female applicant trying to apply, but she did not have publications for the rest 1-2 years, because she was on a maternity leave. The hiring administration decided not to hire her due to that reason»*

The barrier in the form of the family-related obligations was also recognized as a hurdle for the female faculty on the global scale as well (Christensen, 2018; Kuvaeva, 2019; Ruder et al, 2018). However, its effect in Kazakhstan could be more pronounced due to national traditions and cultural sentiments based on the patriarchy relationships led by men. Interviewee #6 reinforced that point as follows:

> *«In Kazakhstan, there is more pressure on female on the way that they need to work and to take care of housework, which is different from Western culture a bit. I can say that because I lived abroad for nine years and know how the culture and social norms are a bit different»*

A few participants also mentioned a lack of tolerance from the administrative side to the family-related obligations, mainly childcare:

> *«I have experienced several times when the head of the department told me that "well we know that you are working here like it is not your primary job" hinting at my household duties»*

Job resources and support

Interviewee #4 focused deeply on having more support in the form of mentorship and communities for female faculty, in which they would discuss various options of work continuity:

> *«In general, once a woman starts her job, she is not even viewed as a person who will progress in her career, no expectations at all. I suggest a positive thing would be supporting mentoring community, where they would discuss options to continue»*

Clearly this is due to absence of reasonable number of female faculty. Taylor et al (2017) and Casad et al (2021) also highlighted the positive effects of mentorship for pre-tenured female professors.

Gender stereotyping

Interviewee #3 listed existing common stereotypes about women that are considered incompatible within the STEM field:

> *«People believe that an efficient person has to be very serious and stale, but I think you can be efficient even if you are emotional, talkative and cheerful»*

> *«There is a stereotype here among teaching assistants with respect to an outfit style. They believe that the more stylish you get dressed, the sillier you are»*

Interestingly, Interviewee #5 stated that being perceived as a "weaker" female has its own benefits and she exploits it in her favor in a sense that male colleagues or those from the administration are tolerent to her performance:

> *«As a woman, you are always in a weaker position, so people forgive you some weaknesses. I see that male colleagues are more supportive toward women given that matter»*

Thus, while stereotypes were an irritant to one faculty, her colleague tried to take advantage of it. She also confessed that the males are more predisposed to be a natural leader than women and links it with the local well-established traditions and norms:

> *«If there are two equal profiles of men and women, I think the men would be preferable for the leading position and I agree with that for two reasons: in our country, leaders are usually men and it comes from our Kazakh traditions; also, they are more stable employees since they don't take a maternity leave»*

Workload distribution

Throughout the interviews with female faculty, there were no signs of complaints about teaching load, indicating that it is standard load as per the job contract's terms. Instead, some of the participants stated that the research workload they must cope with is far superior, especially combining with the family obligations:

> *«Generally, I think women are more comfortable in teaching rather than research, probably. For example, I don't want to be involved in research so much»*

Figure 3 illustrates appearance frequency for different factors identified through the six interviews processed.

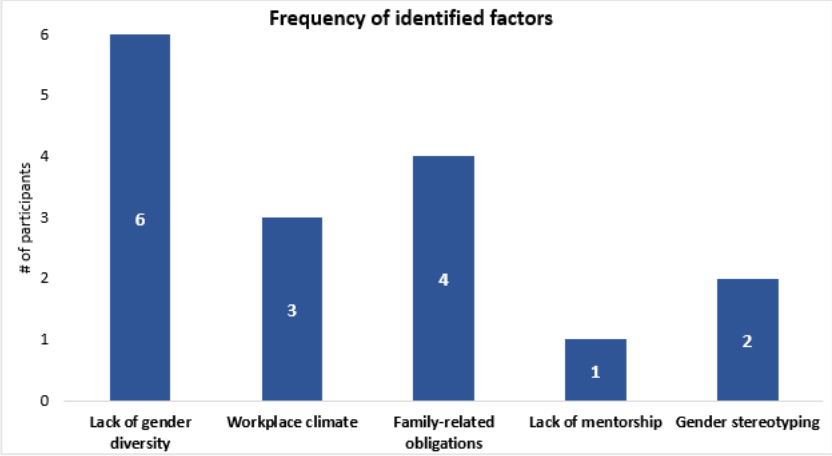

Figure 3: Different factors and their frequency of appearance

It appears that, lack of gender diversity plays the most important part whereas lack of mentorship bears the least significance. Workplace climate, family obligations and gender stereotyping have their fair share as well.

4. Conclusions

This study adopts a framework to identify the factors that hinder women's participation and growth in STEM academic careers in Kazakhstan. Our objective was formulated to test two hypotheses. Findings from this study reveal that Kazakhstani female faculty in STEM experience similar challenges to the counterparts internationally. Some of these challenges are gender disparity, non-involvement in the decision-making process, harsh workplace environment, work life imbalance due to family obligations as well as lack of mentorship. In this context, these factors are primary candidates to be included in the study to assess their relative importance in Kazakhstan.

It is interesting to observe that there is no general dissatisfaction related to teaching and service load in contrast to the literature on the subject (Pascale, 2018; Pedersen and Minnotte, 2017; Ruder et al, 2018). In addition, occasional less expectation from female faculty seems to be contrary to the common belief of the glass ceiling concept. This in turn may cause potential barrier to career growth for female faculty although some may find it temporarily beneficial. To avoid that, the university should make a conscious effort to include females in the top decision-making processes. As Botella et al. (2019) suggest both parties can benefit from the inclusion as it impacts the university and its sustainability potential.

Finally, two additional factors have been identified, namely (i) the cultural and social norms in Kazakhstan; and (ii) the liberal maternity leave policy, which should be included in the study as well.

5. Shortcomings and further research

Considering that the sample of the interview was obtained from one university, there is a question whether the leads obtained are adequately representative.

The pilot study also revealed some methodological issues that should be addressed during the interview process.

- Each question consists of sub-questions making it difficult for the interviewees to structure their responses. Increasing the number of questions so that each question relates to a specific topic could be an improvement.
- An interviewee may be stressed/anxious during the interview. Well-thought arguments and memories do not always come to the mind during the interview (human factor). Sending a list of questions before the interview, will help to generate ideas.
- During the interview interviewees were asked to make a list of positive and negative factors which generated extensive responsive and therefore requires the creation of a structured response.

- To develop the topic in depth and make the respondent more relaxed, the interviewer should be able to ask leading questions, which does not exactly fit the description of a structured interview and hence the interview time may be extended.

The full study will of course be extended to include female faculty from other universities, as well as female students currently studying in tertiary and secondary level of education to better understand the root causes.

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