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Feminization of STEM Education in Higher Education: Arrays of Acceptability and Resistance

Muhammad Shoaib*
Associate Professor, Department of Sociology, University of Gujrat, Gujrat, Pakistan. Corresponding Author Email: shoaibsoc@uog.edu.pk
Rabia Ahmed
M. Phil Student, Department of Sociology, University of Gujrat, Gujrat, Pakistan
rahmed0723@gmail.com
Shamraiz Iqbal
PhD Scholar, Department of Gender Studies, University of the Punjab, Lahore, Pakistan
shamraiznatt@gmail.com
Farooq Abdullah
Lecturer, Department of Sociology, Mirpur University of Science & Technology, Mirpur, AJ&K, Pakistan. farooq.abdullah@must.edu.pk

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ABSTRACT

This study has been designed to examine the feminization in science, technology, engineering, and mathematics (STEM) at higher education institutions, specifically referring to acceptability and resistance. Females are encouraged to continue the traditional careers that include teaching, nursing, and careers in art-related subjects. Currently, females are entering STEM education gradually around the globe. This study opts for a qualitative exploratory research design, grounded in an extensive review of research published documents on the topic, i.e., feminization of STEM education, acceptance, and resistance. A total of 136 peer-reviewed research documents have been systematically extracted from reputable digital databases and other academic resources available through the academic library. The research documents selection process has been continued until data saturation. The inclusion criteria of the study have required that selected studies explicitly address feminization of STEM education, be conducted within the context of higher education, and be published in well-recognized peer-reviewed national and international journals. Further, the thematic analysis technique has been employed to present and discuss the data qualitatively. The study concludes that the feminization of STEM higher education has been shaped by a complex interplay of resistance and acceptability. The study findings reveal that momentous paces have been made in motivating and encouraging female participation in STEM fields. Contrary to it, resistance carries on in elusive and manifest forms, expressing through gender stereotyping, peer biases, lack of role models, specifically, and perceived male dominance in several technical fields in higher education.

Keyword: Higher Education, Acceptability, Resistance, Feminization, STEM Education

Introduction

It has been found that feminine identity has been based on biological characteristics such as body structure, experiences, and traditional roles (Shoaib & Zaman, 2025; Ceci, Williams, & Barnett, 2009). These identities have been shaped and developed by several other factors, such as socio-cultural, socio-religious, socio-economic, and socio-familiar factors (Shoaib, Waris, & Iqbal, 2025c; Jones, 2017). Females are encouraged to continue the traditional careers that include teaching, nursing, and careers in art-related subjects (Goy et al., 2018; Abdullah, Matloob, & Malik, 2024). It is considered that females are more sensitive, emotional, and expressive than males in the past (Shoaib, Waris, & Iqbal, 2025b). The notion has been changed gradually; female students have less preference in STEM and are not as competent as their male counterparts (Shoaib, Waris, & Iqbal, 2025b). However, the enrollment has been insightful, but STEM as a career for female students has not been fully accepted by the socio-cultural environment and patriarchal societies in the world (Shoaib, Waris, & Iqbal, 2025a). Females are responsible for performing their

familial roles, and it is difficult for females to balance their work life with traditional responsibilities (Shoaib, Waris, & Iqbal, 2025a). In patriarchal societies, females are not accepted in leadership posts (Tang, Li, & Crowther, 2023; Abdullah & Nisar, 2024). It has been found that now females are taking part in the labor market and compete with males. Gender is identified by name, hairstyle, clothes, and body language (Washburn & Bragg, 2022). Females have fewer opportunities in political representation (Washburn & Bragg, 2022; Abdullah & Ullah, 2016). Most of the studies found that females make themselves dependent on their families. Females left their interests they think for the benefit of their family (Yu & Jen, 2023; Abdullah & Ullah, 2022). Most of the females make their role models from their families (Shoaib, Tariq, Rasool, & Iqbal, 2025). However, studies revealed that female students do not start choosing their subject as a career because of their traditional roles (Garton, 2024; Abdullah et al., 2024). The experiences and decision-making of females are strongly linked with the feminine identities, which are explained by society (Shoaib, Tariq, & Iqbal, 2025b). In previous years, females had no right to formal education, as education was considered important only for males (Oh, 2024; Abdullah, Nisar, & Malik, 2024). Globally, the feminine identities are dependent on multiple factors such as cultural factors, societal factors, historical factors, structural factors, critical factors, and sometimes females having their own personal factors (Shoaib, Shamsher, & Iqbal, 2025; Abdullah, Nisar, & Ahmed, 2025; Shoaib, Tariq, & Iqbal, 2025a).

Main Objective: This study has been designed to examine the feminization in science, technology, engineering, and mathematics (STEM) at higher education, specifically referring to acceptability and resistance.

The Data and Methods

This study opts for a qualitative approach, an exploratory research design, grounded in an extensive review of research published documents on the topic, i.e., feminization of STEM education, acceptance, and resistance. A total of 136 peer-reviewed research documents have been systematically extracted from reputable digital databases such as Web of Science, Google Scholar, SAGE, Taylor & Francis, Springer Nature, Emerald Insight, and other academic resources available through the academic library. The research documents selection process has been continued until data saturation. The inclusion criteria of the study have required that selected studies explicitly address feminization of STEM education, be conducted within the context of higher education, and be published in well-recognized peer-reviewed national and international journals. Further, the thematic analysis technique has been employed to analyze, identify, and infer patterns across the data. The study findings have been presented and discussed qualitatively in the relevant sections of the study.

Results and Discussions

The study findings outlined that it was important to provide

information to students about gender equality and motivate them to choose the STEM field (Ikkatai et al., 2021). In the same token, the study findings examined that over four decades, there was a noticeable change in the number of females in the science field (Sax, Lehman, Barthelemy, & Lim, 2016). In addition, the argument of the study revealed that there was a link between girls' academic achievement and the support they get from their families. Furthermore, the study of Bieri Buschor, Berweger, Keck Frei, and Kappler (2014) asserted that females choose STEM fields because of their motivational level, support of parents, and their role models. Correspondingly, the study findings showed that there were fewer female students in STEM in China, and there were multiple factors that were the issue (He, Zhou, Salinitri, & Xu, 2020). Comparably, the study of Bennett, Knight, Bawa, & Dockery (2021) indicated that female students in the STEM field were more confident in decision making and about their future than males. Likewise, the study's findings concluded that there were different determinants that affect females to choose STEM subjects at the tertiary level (Quansah, Ankoma-Sey, & Dankyi, 2020).

The study findings outlined that in the 21st century, the number of females in the STEM field was still low (Nanayakkara, 2012). Similarly, the study findings examined that sometimes societal norms occur as a barrier in female education (Muzee & Endeley, 2023). Likewise, the analysis of the study reported that in the time period of World War II, the world focused on female education (Munier, 2021). Comparably, the results of the study indicated that many females were present who prioritize their family roles over their career goals (Mujtaba & Reiss, 2015). Correspondingly, the study findings showed that organizations were trying to promote the education and career of females (Mpuangnan, 2024). Furthermore, the argument of the study asserted that in India, females get scholarships to complete their higher education (Mpofu & Shumba, 2012). As the conclusion of the research articulated, at the time of technology, most of the females were involved in online education (Mounzer & Stenhoff, 2024). The study findings defined that the education of females was necessary for global success (Moser, 2012). In the same vein, the study findings examined that it was important to promote gender equality in education for development (Michael & Alsup, 2016). In addition, the argument of the study revealed that female students join the science field that provides a welcoming environment to them (Menjo Baye, Epo, & Ndenzako, 2020).

The study findings outlined that encourage females from an early age (Shoaib, Shamsher, & Iqbal, 2025). Similarly, the study findings examined that most of the female has STEM abilities, but they don't know about their abilities (Shoaib, Rasool, Kalsoom, & Ali, 2025). Likewise, the analysis of the study reported that the development of any nation was incomplete without the female (Shoaib, Kausar, Ali, & Abdullah, 2025). Comparably, the results of

the study indicated that most of the females preferred the arts field (Shoaib, Iqbal, & Iftikhar, 2025). Correspondingly, the study findings showed that female has less awareness about higher education (Mathrani, Sarvesh, & Umer, 2022). Furthermore, the argument of the study asserted that most of the females feel anxiety from the math subject (Shoaib & Bashir, 2025). As the conclusion of the research articulated that female has fewer role models, most females don't choose a career in life (Shoaib, Ali, & Kausar, 2025). The study findings defined that most of the females have fewer resources for their education (Shoaib, Ali, Iqbal, & Abdullah, 2025). In the same token, the study findings examined that it was important to trust in the abilities of females (Manjokoto & Ranga, 2017). In addition, the argument of the study revealed that females were less likely to hold a leadership post (Shoaib, 2025a).

The study findings outlined that females were weak in the decision-making process. Similarly, the study findings examined that most of the parents were not focused on female education (Shoaib, 2025b). Likewise, the analysis of the study reported that the performance of female students in science depended on their peer group (Malcolm & Roll, 2019). Comparably, the findings of the study indicated that the culture is not supportive of females' education (Ali, Shoaib, & Kausar, 2025). Correspondingly, the study findings showed that most of the females were not dependent on their jobs in life (Mahmood, 2013). Furthermore, the argument of the study asserted that males of the family create barriers in the education of females (Shoaib, Zaman, & Abbas, 2024). As the conclusion of the research articulated, the Female face lacks support from the family (Shoaib, Shehzadi, & Abbas, 2024b). The study findings defined that awareness among females was important for education (Shoaib, Shehzadi, & Abbas, 2024a). In the same token, the study findings examined that sometimes policies bound females to education (Shoaib, Ali, & Abbas, 2024). In addition, the argument of study revealed that female students also have less inspiration in the education of technology (Shoaib, 2024e).

The study findings outlined that females became good problem solvers for society, but it was possible to give them the chance (Lo, 2013). Similarly, the study findings examined that only a few females were in the societies who wanted to start their careers (Little, 2013). Likewise, the analysis of the study reported that most of the girls depended on their family for decision-making about life (Lin, Lin, Wen, & Chu, 2016). Comparably, the results of the study indicated that females face pressure or a burden to fulfill their family responsibilities and career together (Li et al., 2018). Correspondingly, the study findings showed that self-efficacy is sometimes also the reason for the smaller number of females in the science field (Lestari, Stalmeijer, Widyandana, & Scherpbier, 2018). Furthermore, the argument of the study asserted that females do not choose the science and technology field due to their traditional customs and religious beliefs (Lestari et al., 2018). As the conclusion of the

research articulated that there were multiple social problems faced by females in education, co-education was a common one (Lee, 2023). The study findings defined that universities were not nearby (Le, Nguyen, Le, Nguyen, & Nguyen, 2024). In the same vein, the study findings examined that parents prefer male education for future support (Law, 2002). In addition, the argument of study revealed that female has less pressure to provide financial support to their families (Lari, 1996).

The study findings outlined that in Pakistan, education was still a challenge for females (Lall, 2012). Similarly, the study findings examined that access to scholarships for females was necessary for female education (Ladachart, Radchanet, Phornprasert, & Phothong, 2024). Likewise, the analysis of the study reported that a long struggle was behind the female education (Alemagi et al., 2015). Comparably, the results of the study indicated that geographical areas impact the education of females (Ladachart, Kaekai, Khammeetha, Hipthong, & Ladachart, 2024). Correspondingly, the study findings showed that foreign aid has an impact on the education of students (Abass, Opoku, David, Daniel, & Naaela Brown, 2024). Furthermore, the argument of the study asserted that females who take gaps in education face multiple problems (Adu-Marfo, Biney, & Asamoah, 2024). The conclusion of the research articulated that in societies, there was a lack of female scientists (Alcántara-Manzanares, Torres-Porras, & Mérida-Serrano, 2024). The study findings defined that in rural areas, females face more challenges in education (Ali, Khan, & Alam, 2021). In the same token, the study findings examined that provide equity in education to all genders (Arkorful et al., 2020). In addition, the argument of study revealed that there were multiple dimensions for promoting the balancing in education in every field (Asamoah, Nketiah-Amponsah, Danquah Ansong, & Agyekum, 2023).

The study findings outlined that the involvement of parents was important for the success of children in education (Shoaib, 2024d). Similarly, the study findings examined that violent behaviors were occurring in higher educational institutions (Shoaib, 2024b). Likewise, the analysis of the study reported that ethical education was necessary for the students (Shoaib, 2024c). Comparably, the results of the study indicated that students consider their teachers as role models and they learn from them (Shoaib, 2024a). Correspondingly, the study findings showed that pedagogical skills were important to increase the number of female students (Shoaib, Usmani, & Abdullah, 2023). Furthermore, the argument of the study asserted that in Pakistan, there was a lack of libraries and library was the main source of knowledge (Shoaib, Shehzadi, & Abbas, 2023). The conclusion of the research articulated that it was important to explain the importance of education with reference to religion (Shoaib, 2023b). The study findings defined that workshops and developmental programs change the perception of societies toward girls' education (Shoaib, 2023a). In the same vein, the study findings

examined the group of friends' effect on the decision-making of an individual (Alexander, 2004). In addition, the argument of study revealed that in Pakistan, females face barriers in higher education (Shoaib, Tariq, Shahzadi, & Ali, 2022).

The study findings outlined that in most of the societies, females were not considered as leaders; they face challenges (Ali, Shoaib, & Abdullah, 2022). Similarly, the study findings examined that policy making was necessary for the impact of global powers on it (Shoaib & Ullah, 2021a). Likewise, the analysis of the study reported that most of the females are not ready to choose a science subject because they have no pressure to earn (Shoaib & Ullah, 2021b). Comparably, the results of the study indicated that in most of the societies, it has been considered that males were sharp in calculation in mathematics (Shoaib, Iqbal, & Tahira, 2021). Correspondingly, the study findings showed that there was gender equality in education (Shoaib, Iqbal, et al., 2021). Furthermore, the argument of the study asserted that there were also some inequalities in India toward choosing the field of education (Shoaib, Fatima, & Jamil, 2021). The conclusion of the research articulated that students choose subjects according to their socio-economic background (Shoaib, Ali, & Akbar, 2021). The study results explained that there was a link between choosing STEM subjects and job satisfaction (Shoaib, Ahmad, Ali, & Abdullah, 2021). In the same vein, the study findings examined that the curriculum was not satisfactory in most of the developing countries (Ansari, Fasih, & Humphry, 2024). In addition, the argument of the study revealed that feedback from teachers and friends was important for the achievement of students (Shoaib, 2021).

The study findings outlined that at the time, technology was the main tool for providing information to societies about education (Archila, Forero, Truscott de Mejía, & Restrepo, 2024). Similarly, the study findings examined that science students have better decision-making sense and they analyze themselves (Archila, Molina, & Truscott de Mejía, 2018). Likewise, the analysis of the study reported that computer science higher education students have better job opportunities (Armoni & Gal-Ezer, 2014). Comparably, the results of the study indicated that easy and practical knowledge was important for the science students (Asunka, 2013). Correspondingly, the study findings showed that multicultural challenges were faced by science students (Atwater, 2010). Furthermore, the argument of the study asserted that the examination system and social justice system of the country also impact the learning process of the students (Atwater, Butler, Freeman, & Carlton Parsons, 2013). The conclusion of the research articulated that gender equality and mobility must be present in the societies (Bagheri, 2019). The study findings defined that traditional roles of females occurred as a barrier in the education (Bambara, Wayack-Pambè, Ouili, Guiella, & Delamou, 2023). In the same vein, the study findings examined that most of the females do not get higher education due to their marriages (Bambara

et al., 2023). In addition, the argument of the study revealed that it was important to improve the quality and experiences of teachers for the better education of future students (Barnes & Cross, 2020).

The study findings outlined that females choose the arts field and reject science due to multiple reasons and challenges (Belova, Chang, Rundgren, & Eilks, 2015). Similarly, the study findings examined that over the past few decades, the number of students in the computer and science field in Greece has increased (Berdousis & Kordaki, 2018). Likewise, the analysis of the study reported that to increase the number of female students in STEM, it is necessary to give training to the female teachers and raise their awareness (Berge, Chounlamany, Khounphilaphanh, & Silfver, 2017). Comparably, the results of the study indicated that there was a difference between the students in their parents ' education (Bicer, Capraro, & Capraro, 2018). Correspondingly, the study findings showed that most of the females were doing their online jobs after STEM education and getting good grades (Binmohsen & Abrahams, 2022). Furthermore, the argument of the study asserted that females also perform well in the STEM field, necessitating giving them a chance (Boyle, McGettrick, & O'Sullivan, 2024). As the conclusion of the research articulated, every student has their own experiences about the STEM field (Chang & ChangTzeng, 2020). The study findings defined that students with science majors were more focused on career opportunities (Chang et al., 2020). In the same token, the study findings examined that females who were migrants face more problems compared to the other students (Chee, 2018). In addition, the argument of the study revealed that parents had an impact on the decision-making and interest of the students (Chen, Chow, & So, 2022).

The study findings outlined that most of the females were personally denied higher education due to family reasons (Chin, 2005). Similarly, the study findings examined the experiences of STEM students who were doing a study and a job at the same time (Ahmad, Shoaib, & Shaukat, 2021). Likewise, the analysis of the study reported that most of the females do not manage their traditional roles with their career, and they give up their career (Ahmad, Ahmad, Shoaib, & Shaukat, 2021). Comparably, the results of the study indicated that there were multiple factors that impacted the teacher and students with science subjects (Shoaib, Abdullah, & Ali, 2020). Correspondingly, the study findings showed that most of the students denied the science subject, as they think that it is a difficult subject (Shoaib & Ullah, 2019). Furthermore, the argument of the study asserted that there was creativity in STEM and that it depends on the females who are attracted more (Shoaib, Latif, & Usmani, 2013). As the conclusion of the research articulated that female has less stress about income and job security (Anwar, Shoaib, & Javed, 2013). The study findings defined that motivation was important for the females to perform well in the education and career field (Abdullah, Usmani, & Shoaib, 2023). In the same token, the study findings examined that only a few students were present who made

their decision by choice and interest (Shoaib, Shehzadi, et al., 2023). In addition, the argument of study revealed that students start getting interested in and information about the subjects from their family (Shoaib, Naseer, & Naseer, 2023).

The study findings outlined that the science subject has a bright future in Arab states, and students have more opportunities than their counterparts (Dagher & BouJaoude, 2011). Similarly, the study findings examined that females face problems in technical subjects compared to their male counterparts (Dart, Trad, & Blackmore, 2021). Likewise, the analysis of the study reported that in developing countries, it was necessary to build separate science institutes and science museums (Dawson, 2014). Comparably, the results of the study indicated that in Canada, female students were taking an interest in the science field and in career jobs (DeCoito, 2016). Correspondingly, the study findings showed that the self-efficacy of teachers was also important for the achievement and success of the students (DeCoito & Myszkal, 2018). Furthermore, the argument of the study asserted that there were multiple factors that impact the motivation of the student in Pakistan (Din, Abbas, & Abdullah, 2023). The conclusion of the research articulated that gender also matters in making decisions about choosing a subject (Dohn, 2022). The study findings defined that before taking any decision, career information seeking was important (Dutta, 2009). In the same token, the study findings examined that female students were not only facing the challenges at the time of education, but they also faced barriers during job opportunities (Farahat, 2009). In addition, the argument of the study revealed that females face the barriers of wage gaps while in a career in the labor market (Fichtenbaum, 2006).

Conclusion

The study concludes that the feminization of STEM higher education has been shaped by a complex interplay of resistance and acceptability. The study findings reveal that momentous paces have been made in motivating and encouraging female participation in STEM fields. Specifically, higher education has been deeply embedded and linked with gendered expectations, socio-cultural norms, institutional, and structural barriers. It endures to impact the scope of acceptance and resistance practiced by female students in higher education. Similarly, factors including gender based sensitive policies, supportive family, peer, and faculty networks, and increasing societal responsiveness have been contributing positively to the acceptability of females in STEM disciplines, specifically in higher education. Similarly, personal motivation, parental and familial inspiration, institutional initiatives, and structural support networks promoting inclusivity have also been found to boost female engagement and retention in STEM higher education. Contrary to it, resistance carries on in elusive and manifest forms, expressing through gender stereotyping, peer biases, lack of role models, specifically, and perceived male dominance in several

technical fields in higher education. These multiple resistive factors often obstruct the academic confidence, motivation, performance, job orientation, and career ambitions of female students in STEM higher education.

Future Implications

The study raised the need for a multidimensional methodology that addresses social, structural, cultural, religious, personal, and psycho-social dimensions to further feminize STEM higher education. It includes consolidation of gender equality and equity policies, nurturing comprehensive and inclusive learning environments, integrating gender based responsive pedagogy, promoting mentorship programs, and leadership opportunities for females in STEM higher education.

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