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Determining the Effect of Social and Academic Support on STEM Confidence and Learning Environment Among Female Engineering Students in Pakistan

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Abstract: Gender inclusion and female participation in STEM courses have always been challenging in a patriarchal country like Pakistan. Women are often underrepresented in engineering fields, as engineering fields are usually considered manly. Female students confront many challenges, be it workplace or educational institutes. Some of the self-perceived and determined challenges are discussed in this study. As determined through this research study, factors affecting female participation are low STEM confidence, Gender disparity, Social and Academic Support, and Learning Environment. Empirical Evidence is collected using a questionnaire with 25 items based on the Likert scale. The dependent variables are STEM Confidence and Learning Environment, whereas the independent variables are Social and Academic Support. Participants included 170 female UG and PG engineering students from 4 universities in Pakistan. Data were collected through the Questionnaire, which included an online survey. Correlation method and statistical test MANOVA were applied, using SPSS 21 to determine the effect of social and academic support on STEM confidence of female students and to find a relationship between the variables. Results indicate a positive correlation between the variables STEM confidence and social and academic Support and Learning environment, whereas a slight correlation has been observed between social Support and LE. MANOVA results indicated a significant effect of Social and Academic Support on the STEM confidence of female students. Empirical Evidence shows that Social and academic support can affect the STEM of female engineering students, and the LE of females can also be affected by social and academic Support.

Keywords: Female educational challenges, gender gap, gender in STEM, STEM confidence, social and academic support

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1. Introduction

Engineering education is the activity of imparting knowledge and principles to the professional practices of engineering and hence is considered the key factor that leads to any country's commercial and industrial development. It includes science, technology, and Mathematics as its main curriculum courses. These are the essential components for the development and growth of any country, either in the economic or industrial sector, as stated by Jackson (2010). In industrialized nations, despite some movement away from gender-stereotypical attitudes in career choices, there remain gendered patterns in subject choices in STEM and related career aspirations (Ibrahim et al., 2022). Science, Technology, Engineering, and Mathematics are often perceived as male domains, and those working in these fields are predominantly males (Makarova et al., 2019). This gender gap creates consequential demand for engineering education to evolve and be inclusive enough to include both males and females to get an efficiently trained variety of talented engineers, including males and females, to deal with critical challenges with innovative solutions. STEM and Technical education play a vital role in the entire process of learning and the social and economic development of the countries.

The critical and social challenges of the future will have to be resolved and fixed by current engineering graduates, which might help in applying their innovative knowledge to fix and resolve the newer and complex critical and social challenges that were never observed before. Science, Technology, Engineering, and Mathematics are often perceived as male domains; thus, people working in these fields are predominantly males. Prominent features of Sustainable Development Goals by the United Nations include gender equality, quality education, and no inequality. While scrutinizing the Engineering-stereotype Madara and Cherotich (2016) state that engineering is envisaged as a masculine, too hard, noisy, and dirty profession. In addition to this, another stereotype females face is that females are perceived as weak, delicate, inferior, dependent on others for their tasks, and likely to have a lower intellectual ability, less logical mind, and less efficient than their male counterparts. In terms of growth, it is assumed generally that equal contribution may lead to the development of Economic culture. However, In general, emphasis in engineering fields is given to male students compared to female students. In addition to this, engineering education is also considered male-dominant (Madara and Cherotich, 2016) and manly discipline (Makarova et al., 2019).

The persistent phenomenon of gender differences while choosing career paths has also been demonstrated in the Global Gender Gap Report presented by the World Economic Forum (WEF) 2016, which states that females are often observed to be discriminated hence showing an underrepresentation of female gender technical fields such as Engineering and Technology, whereas being considering the fact of gender underrepresentation, males are commonly under-represented in nontechnical fields like health and education. It is often observed that similar issues related to gender in STEM are also present in engineering institutes in Pakistan (Mehmood et al., 2018). Looking into the perspective of the Pakistani context, particularly the Higher education system (Khurshid, 2016), the enrollment of females compared to males in engineering and technology-related fields is relatively low (Charlesworth & Banaji, 2019). Empirical evidence has also supported the notions. According to the Ministry of Female Development Pakistan, only 19% of females have attained education up to Matric, 8% up to Intermediate, 5% a Bachelor's degree, and 1.4% achieved a Master's degree. 60% of the female adult population is illiterate. Female students are often seen as marginalized and under-represented in STEM and engineering technology (Khurshid, 2016). Starovoytova & Cherotich (2016) states that the main challenges occur when engineering and gender challenges take place simultaneously. The occurrence of combined engineering and gender challenges provides the basis of the most important engineering stereotype. Keeping in view these circumstances and the increased gender gap, engineering education thus creates a loophole that needs to be filled in order to get an anthologized group of engineers, including both males and females, who are successfully trained to deal with critical future challenges. STEM and technical education contribute to the educational system (Charlesworth & Banaji, 2019). It also contributes majorly to the social, commercial, and industrial advancement of the countries. The fact that is already accepted is today's students will become the change-makers for the future (Makarova et al., 2019).

Although prevailing preferences have deemed that the ratio of female students in STEM, as compared to men, is low, female inclusion can greatly benefit the engineering task force (Charlesworth & Banaji, 2019). Ignorance of this phenomenon may result in a lack of female participation, which can lead to the exclusion of the female workforce from STEM and other Engineering courses (Starr & Simpkins, 2021). Therefore this study focuses on self-perceived and defined challenges and the factors that lead to less female participation in STEM and other related engineering courses. Particularly identified challenges are gender disparity in STEM courses, lack of STEM confidence, lack of social and academic support by family, teachers, and peers, and the learning environment of female students.

The main focus of this research study based on the background and related issues is to identify the reasons and factors causing the underrepresentation of females in STEM-related fields of study and in choosing STEM as a career field. By acquiring the information from the female students using a quantitative survey method, the authors anticipated discovering the effects of social and academic support to gain STEM confidence in females. Furthermore, it aims to investigate whether there exists any relationship between social, academic Support, learning environment, and STEM confidence of female Engineering students and to identify exactly the barriers. In addition to this, it is also scrutinized why these challenges are still so prevalent and what steps might be taken and suggested for the future to identify the loophole and break this gender gap in STEM Education in Pakistan.

2. Literature Review

Traditionally female students have been observed to be marginalized in the field of engineering and technology (Charlesworth & Banaji, 2019). Male staff outnumbers the workforce in engineering institutions as Higher Educational institutes have also been unsuccessful in addressing the challenges of cultural diversity. Hence there are not enough female role models to inspire female students to enter and remain in engineering departments at higher education institutions (Khurshid, 2016). While observing the causes of the gender gap in STEM participation, some of the reasons determined have been linked with family influences and social class differences, as said by (Idris et al., 2020). In addition to this (Ibrahim et al., 2022), stated that girls are observed to be less likely to enjoy their STEM lessons and feel that they are not able to experiment with STEM ideas and discuss them confidently. On the other hand, boys have more positive attitudes toward STEM courses (Ibrahim et al., 2022).

Within the Pakistani context, a few investigations have been conducted to identify the gender gaps in STEM and critically analyze the reasons causing gender disparity in STEM (Mehmood et al., 2018). Some studies on similar topics have measured the difference between the attitudes of both genders in science and technology courses. Girls getting primary-level education have more positive attitudes toward science as compared to boys but often receive a relatively low score in choosing STEM as a career interest (Hashim et al., 2022). Hence providing the basis to the discussion that there might exist a loophole due to which females hesitate to choose STEM as their career. Another similar study also concluded related findings at the secondary level (Rehman & Butt, 2020), although, for career choice and interest in science, no gender difference was identified. The challenges are discussed in detail below.

2.1 Gender Disparity

Gender disparity or biases can be defined as the favour of one gender over the other. Batara (2018) describes gender disparity as purposely or deliberately demonstrating against women in the form of excluding, hindering, abusing, damaging, or discriminating against women in some way or the other. Gender Equality and Women empowerment are among Millennium Development Goals and stand at the eighth number to be fulfilled as an important goal. According to UNESCO Institute for Statistics (UIS) data, less than 30% of the world's academic researchers are females. UIS data also show the extent to which these women work in the public, private or academic sectors, as well as their fields of research exploration. Numerical data presented by the American Society for Engineering Education (2018), shows that only 13 per cent of the engineering workforce are females. The statistical data shows significant underrepresentation of females in STEM-related courses and the trend continues to be obvious throughout different countries and has been observed over time as stated by Freeman and Roberts in 2013, Roskes and Slattery in 2010 and by Cunningham back in 2005. According to Adlyn (2013), tracing gender-stereotypical issues faced by female students can help overcome their interest issues in engineering subjects as self-described by the female participants of his study.

One of the factors that are leading to Gender Disparity in STEM is the misconceptions about STEM. (Charlesworth & Banaji, 2019) considers these misconceptions to be a key contributing factor to female underrepresentation in STEM and engineering fields. Diana (2016) further adds to the discussion that most people perceive an "Engineer" to be a person who does manual work or tasks that include heavy machinery, another factor considered as a component for discouraging the female population in STEM is that most of the times when representing any Engineering work, grease behind the fingernails' image is shown, thus leading to the misconception of Engineering to be a manly field (Makarova et al., 2019). Marginson (2013) discusses some of the arguments in the regard that the underrepresentation of females in STEM courses can affect the STEM learning life and workplace in his study. He states that, in order to better align with STEM research, it is important to find the gender balance in STEM that aligns with the gender balance in the real world. He further adds that women's participation enhances intelligence and reduces potential collective discrimination to help enhance the quality of STEM research. Ceci et al (2014) observed that innate or invariant abilities might not exclusively shape gender differences but maybe influenced by sociocultural factors.

Starr & Simpkins (2021), concluded their research by finding out that the barriers to female participation in STEM courses and education is related to gender stereotypes. The quest to identify gender issues related to social-psychological barriers leads to research that states parents' belief of boys are more interested and capable in STEM courses and girls find STEM courses to be difficult, plays a part in gender stereotyping (Idris et al., 2020). Similarly, teachers also practice the same, without any conscious intention to convey gender stereotyping in STEM subjects. Some of the factors included for female underrepresentation in STEM career fields are prejudice and biases against females, family obligations of females, societal double binds, and lack of mentors and role models (Luttenberger et al., 2019).

2.2 Social and Academic Support from Family and Teachers

Social Support can be construed as a person's perception and the actuality that someone from their social circle is available to assist them or support them with their behaviour (Baria & Gomez, 2022). This Support can be in the form of tangible or intangible resources provided by any individual from the social network. Academic Support mainly includes Teacher and Peer Support at educational institutes in terms of academia during the process of learning (Johnson and Johnson). He further adds to the definition that social support in a classroom environment is the key element that affects the overall aspects of student achievement. The layout of social and academic Support can be further explained in the sense that the persons who are there for academic scaffolding and provide assistance to achieve goals provide academic Support whereas social support is provided by caring for.

Social support provided by teachers and peers can contribute to positive psychological health, constructive management of stress, and better academic achievement. (Luttenberger et al., 2019) states that various characteristics of classroom teaching show considerable effects on students' academic self-concept and their interest in a subject. Literature studies show that parents' attitude to STEM is positively related to the STEM concepts (Idris et al., 2020), values and attributes of the child (Acosta and Hsu 2014), STEM achievement and career choice (Svoboda et al. 2016; Acosta and Hsu 2014). Bieg and Dresel (2018) state that teachers' support in the attribution of achievements might help students overcome gender-specific attribution patterns. In Support of this, it was stated that Teachers' behaviour can support students' interest and their improvement of a positive academic self-concept and encourage students to perhaps even experience STEM as their favourite field, all while keeping in view that effects from another side of the coin are possible as well (Luttenberger et al., 2019). Bieg and Dresel (2018) stated that teacher support develops an educator's connection with a student. Unambiguously, teachers who support students show their care and concern for their students, so these students often reciprocate this concern and admiration for the educator by following classroom standards (Benlahcene et al., 2021). Teacher and students interactions play an important role in creating an effective learning community (Inkelas et al., 2018), thus creating an ideal learning environment where students can foster a sense of belonging and can form connections efficiently besides fostering students engagement in the classroom, the student's interaction in the classroom is more likely to be focused on academic work and group projects (Struyf et al., 2019).

When looking back in 2000, Miller added to this and stated that when teachers shout at students, blame them, or aggressively try to correct them; these students often show less apprehension for their teachers and fewer supportive classroom behaviours. And even though back in 1996 Lutz supported this topic by explaining the phenomenon that female undergraduates tend to receive more teacher support than male students. Some empirical studies show that gender differences can be a link between teacher support and indicators of mixed students' academic emotions, such as anxiety, depression (Starr & Simpkins, 2021)), hope and interest and other emotions (Bieg and Dresel, 2018). A Similar concept of social support acting as a positive facilitator has been empirically proved by Marotto and Bolotin (2018), as it was stated that opportunities provided by parents to their children towards facilitation of learning STEM can inculcate positive attitudes of children towards STEM career choices. It was further elaborated that Support by parents can be a useful factor to cultivate the interest in STEM-related career aspirations in children, by helping them explore science and creating a culture of STEM encouragement at home (Marotto & Bolotin, 2018).

2.3 Lack of STEM Confidence

Academic self-confidence comprises a person’s self-assessments in academic areas. It includes feelings of self-confidence and competence that are mainly formed through experience and interpretations from the individual’s environment oneself (Han et al., 2021). Females have been observed to have a more critical academic self-concept in STEM as compared to males, in many developing countries. These differences can have a negative impact over time as research shows reciprocal relation between student achievements and academic self-concept (Han et al., 2021) Han further elaborates the argument that the reciprocal effects model was established between students’ accomplishments and their academic self-concept and vice versa. This insinuates that when comparing the students with higher academic self-confidence and with low academic self-confidence in their course scores over time, the students with high academic self-confidence will score higher in academic domains. This effect can be further explained by the theory of value expectancy in how undergraduates with a higher academic self-concept in a domain have higher expectations regarding their chances for successful outcomes and as a result have a higher motivation to invest time and effort into learning activities in this domain (Luttenberger et al., 2019).

Female engineers often do not feel valued and good enough as highly as their male counterparts, leading to immense low confidence and self-doubt as stated by (Makarova et al., 2019). The United Nations International Labor Organization has also highlighted the urgent need for countries to address gender discrimination and marginalization in the scientific and technological fields and to change the traditional attitudes that exist in these sectors; in addition, if these issues won’t be highlighted then it would constitute to the obstacles the progress of the nations. Luttenberger et al. (2019) conducted a research study which indicates that females in engineering generally report lower self-confidence and self-efficacy than males. A study conducted amongst high school students which have shown that females reported lower self-efficacy in math and science when compared to males. Similarly, According to Makarova et al. (2019), male students in STEM had the strongest belief of Mathematics is a male domain. Rasid et al. (2020) had a contrasting belief related to females’ confidence in STEM courses as they state that by middle school, more than twice as many boys as girls want to work in science or engineering-related jobs. In a research study among first-year university students, it was indicated that negative stereotypes of women’s engineering and calculated ability were more strongly endorsed among male students and female students were more probable to report higher insights into their engineering abilities (Hashim et al., 2022). He further stated that females consider themselves lower than boys with the; labelled Self

Perception of the ability. Moreover, it is observed that female engineers do not feel valued or respected enough as compared to their male counterparts, which leads to a lack of self-confidence in female students in STEM (Makarova et al., 2019).

Luttenberger et al. (2019) state that females do avoid STEM subjects because of the stereotyped and negative perception of these subjects. He further added to the term stereotypical perception such that; it is about the abilities of a specific gender in specified subjects. Stereotypical issues are mainly promoted by the social and cultural contexts of a person, thus making negative stereotyping to be the main reason females avoid STEM subjects. Most females in the West still believe the stereotype that STEM subjects and professions are still male domains (Starr & Simpkins, 2021). Professional stereotypical issues can cause strong implications for females, can impair learning and prevent females from fulfilling their full potential, affect the career choices of individuals, and lower the self-concept and sense of competence of females (Luttenberger et al., 2019).

2.4 Learning Environment

A learning environment can be defined as a designated or contextualized setting or climate mainly created to achieve specific educational goals (Closs et al., 2021). Thus a learning environment can be comprised of specified psychological and physical aspects where goal-oriented teaching takes place either in a classroom or in any virtual or non-traditional environment (Struyf et al., 2019). The challenges faced by female students in engineering classrooms could probably adversely affect the performance of female students academically, be it the comments given by teachers or by any other class peer. Luttenberger et al. (2019) describe an engineering classroom environment as full of burdensome courses and other challenges. These challenges include fewer female students in technological and engineering courses, females being isolated, or being left alone. He further elaborates on the challenges female engineering students face in the class (Struyf et al., 2019). Female engineering students also reported being unable to ask questions confidently as they feared that fellows might mock them. Literature states that some female students also reported that they were not taken seriously by lecturers and course instructors (Aslam et al., 2022). They also reported that they feel less respected in class as compared to their male fellows. Thus, they feel the need to prove themselves by working extra tough to achieve the same respect as their male counterparts. Gender-related provocations faced by female learners in learning mechanical and mathematical courses could inhibit them from achieving their fullest potential (Luttenberger et al., 2019). Moreover, it is revealed through studies that the learning environment of students has a positive correlation with the students learning in general (Charlesworth & Banaji, 2019).

2. Research Questions

Since some previous studies indicate a significant effect of academic and social Support on the STEM confidence of female students while different studies indicated inconsistent outcomes, furthermore numerous studies indicated a relationship between Social, Academic Support, Learning Environment, and STEM confidence of female Engineering Students, hence this helped the author to formulate the objectives of the study. The primary objective is to find out the main challenges and the factors that lead to the underrepresentation of females in STEM and engineering-related courses.

As obvious by the objectives of the research study research questions are as follows:

RQ1. Is there any effect of Academic Support on the STEM confidence of Female students?
RQ2. Is there any effect of Social Support on the STEM confidence of Female Students?
RQ3. Is there any relationship between Social, Academic Support, Learning Environment, and STEM confidence of female Engineering Students?

3. Research Methodology

4.1 Research Design

This study applied a survey-based research method, including both Qualitative and Quantitative Research methods. The survey method mainly focused on the techniques of the cross-sectional survey design in the current research study. The qualitative part of the study was also used as the basis for the quantitative instrument, the questionnaire. Four variables: Social Support, Academic Support, STEM confidence, and Learning Environment are participatory factors for the analysis of the study. Survey questions used the 5-point Likert-type scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) to assess the questions included in the questionnaire. A cross-sectional survey design was used here to measure the community's needs in terms of educational requirements, such as the challenges faced by female engineering students while studying STEM courses and choosing STEM as their career choice.

4.2 Sampling Techniques

Simple random sampling proceeding with the Purposive Sampling Technique is applied to archive the data for the research. Simple random sampling is used as the engineering students were concerned. The purposive sampling technique is used when a researcher chooses a specific population for the study (Cohen et al., 2007). Hence, females were chosen among engineering students due to the purpose of the study. The data was collected using an online questionnaire survey from female students of different engineering fields pursuing their education at the post-graduate or undergraduate level in STEM courses participated in the study; STEM Educational study fields involved female students from Chemical, Mechanical, Electrical, and Software Engineering. Female Participants from 4 different universities in Bahawalpur, Islamabad, Peshawar, and Sargodha were included in this research study. Figure 1. shows the representation of the sampling process in this research study.

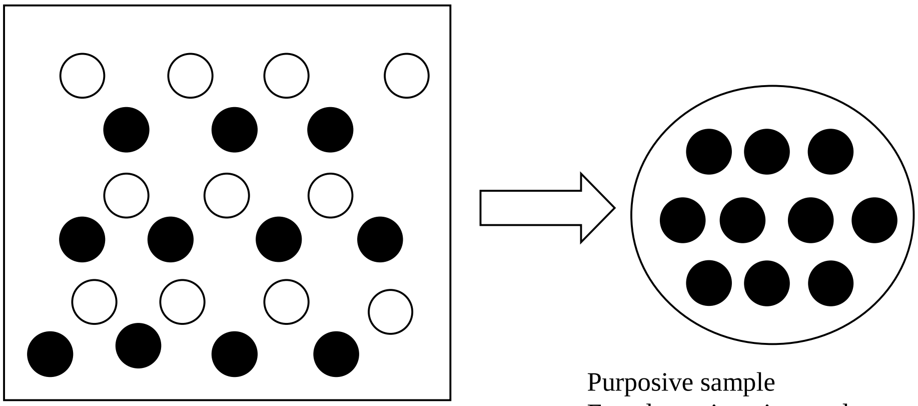

Fig. 1 - Purposive sampling

The questionnaire, prepared on Google Forms, was then distributed to 4 different universities through the Google Form link. Social media channels, including Facebook, WhatsApp, and emails, were used to contact female university students. Due to the global pandemic, the surveys were conducted online. Almost 190 individuals were approached. However, only 170 female individuals returned the questionnaire with their valuable feedback and filled out the overall Survey Questionnaire, explained in this study.

4.3 Instrument

The survey questionnaire prepared for this Research study is adapted by underpinning the foundations of two questionnaires: the PACE survey questionnaire by Elizabeth Litzler and Cate C, and the CFESQ tool from Okwelle and P. Chijioke. A survey questionnaire is a method that uses commercially available instruments or can adapt any, each of which measures different aspects of the culture (Cohen et al., 2007). The PACE survey instrument was pretested on undergraduate engineering students at a university, then modified based on the feedback, and reviewed by a panel of science and engineering diversity experts. The survey was then analyzed for internal consistency and found to have a mean of 0.77 (Litzler and Young, 2014). CFESQ is prepared and analyzed by Okwelle, P. Chijioke. The questionnaire contains 63 items of a five-point Likert scale type, It was verified by three university experts using the Cronbach alpha method, and a reliability coefficient of 0.85 was obtained. The main purpose of this Questionnaire was to examine self-recognized challenges faced by undergraduate female students in pursuing engineering at a University in Nigeria.

The adapted questionnaire used in this Research Study was named the EECFFS Questionnaire (Engineering Education and Challenges Faced by Female Students Questionnaire), comprising 25 items based on 5 points Likert scale. The Likert scale was used to express the degree of agreement or disagreement with the items: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. Two experts validated the Survey Questionnaire; one was from the Institute, whereas another was selected as an external Expert from a Malaysian University. EECFFS Survey items appear in Appendix Section. Questionnaire items 1-8 are associated with variable STEM confidence; 9-16 are the identifiers for variable Academic Support, 17-21 and its further distribution are the used for variable Social Support, 22-25 are used for Learning Environment.

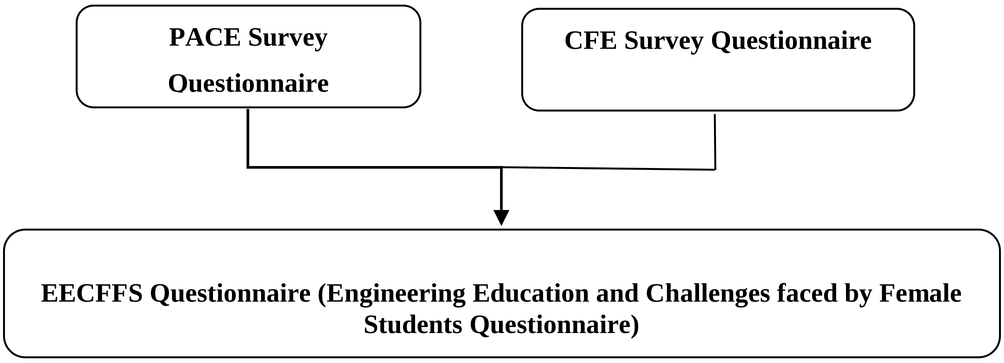

Fig. 2 - Instrument adaptation

Figure 2 shows the hierarchy of the adaption of the instrument used in the study. The instrument used was adapted by underpinning the mains of two questionnaires, the PACE Survey Questionnaire and the CFE Survey Questionnaire.

4.4 Data Collection and Procedure

EECFFS Questionnaire was distributed via Google Form Link among female students of different Public and Private universities through email contacts. At the beginning of the data collection procedure, keeping in mind the other additional concerns that were Pakistan being a population of patriarchal norms and beliefs, a challenge here was obtaining an ample population of female students with a high interest in STEM subjects and having career objectives which were ready to volunteer for the study by giving their valuable time. This problem was then solved due to amid situation of COVID, which transformed the Education System to the online mode for the time being. Due to the pandemic and lockdown in the country, the questionnaire was distributed online to the universities involved in the research study.

The data were collected from different public and private universities in Islamabad, Sargodha, Peshawar, and Bahawalpur. This demographic difference helped in providing more in-depth exposure to the challenges faced by females in the field of Engineering. Since the surveys were conducted with students from different public and private Universities in Pakistan using Purposive Random Sampling Techniques. So, the results were evaluated independently, without considering the type of backgrounds or socioeconomic statuses of the participants. As mentioned earlier, the data for the questionnaire was collected online using Google Forms, so there was no missing data initially in the form as the entire Questionnaire items were marked required using the Google form attribute. This was done eventually to avoid any missing items, further.

4.5 Data Analysis

The data collected through 170 survey questionnaires were then analyzed using correlation analysis and MANOVA using IBM SPSS version 21. Statistical test MANOVA was preferred along with the correlation analysis because all dependent variables are considered in the same analysis; it takes account of the relationship between outcome variables (Barbosa de Sousa, 2020). Further elaborating on the process, MANOVA can explain the difference in a combination of dimensions. Hence, this study is used to determine the effect of social and academic support on the STEM confidence of females and the effect of the Learning environment on the STEM confidence of females, thus determining the relationship among all the variables in consideration.

The bivariate correlation analysis method was applied to find the correlations between the dependent and independent variables. The preliminary assumption for normality testing was performed on the data to check it for normality issues such as linearity and multivariate outliers that might reflect and identify the outliers in the data if any. Winsorization was used to eliminate some outliers from the initial data. This method is used when an outlier or extreme value is found in a sample, it is not simply rejected. The extreme value or outlier is replaced by the nearest value of observation, known as the Winsor mean.

4. Findings and Discussions

Data were prepared for analysis after the data collection procedure and entered into SPSS 21. First, correlation MANOVA was performed to determine the significance of the scores of the survey questionnaire. Multivariate variance analysis, abbreviated as MANOVA, was chosen among the statistical tests because it allows testing hypotheses that show the effect of multiple independent variables on multiple dependent variables. Stem Confidence and Learning Environment were considered dependent variables, whereas Social and Academic Support were used as independent variables.

Following is Figure 3 which shows the cause-effect relationship between the dependent and independent variables of the current study.

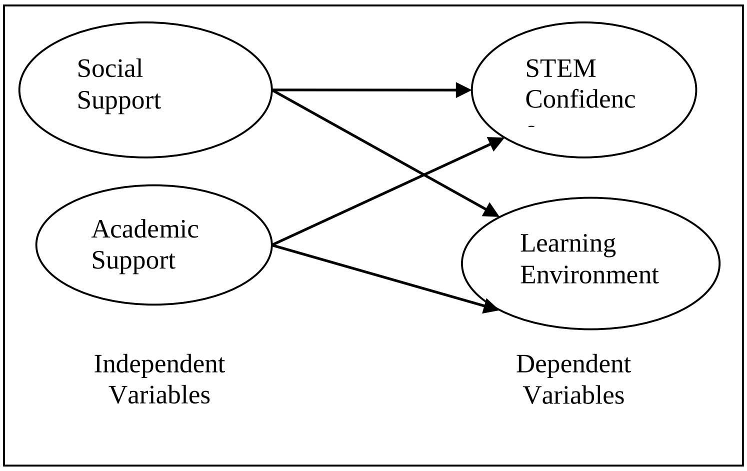

Fig. 3 - Cause-effect relationships of dependant and independent variables

5.1 Descriptive and Correlation Analysis

Descriptive Statistics of the variables is given as following, in table 1:

Table 1 - Descriptive statistics and correlational coefficients of the variables of study

Variable	M	SD	1	2	3	4
1. Stem Confidence	2.46	0.74	-			
2. Academic Support	2.2	0.54	.422*	-		
3. Social Support	2.6	0.86	.687**	.335*	-	
4. Learning Enviroment	2.44	0.77	.691**	.591**	.590**	-

**p<0.01 ; *p<0.05; n=170

STEM confidence with Academic and Social Support

These statistical results show that there is a positive correlation observed between academic support and STEM confidence with a value of $r = 0.422$, thus providing an answer to the first research question. Here it can be stated according to the empirical evidence that Academic support can eventually enhance STEM confidence in females.

Learning Environment with Academic and Social Support

Moreover, for the proceeding research questions, as the significance of Academic Support on Learning Environment is seen to covariate positively with $r = 0.691$, whereas a moderate correlation has been evidenced between Social Support and Learning Environment with coefficient value $r = 0.590$, hence it can be stated here that proper Academic Support can contribute to forming a good learning environment.

The result of this analysis is consistent with the analysis conducted by Bieg and Dresel (2018). This is also stated in the literature of the current study that the Support provided by teachers to achieve a specific target or objective might help contributes to overcoming gender-specific assignment patterns. His study further added that in Support of this notion, Luttenberger et al. (2019) stated that Teachers' behaviour can support students' interest and their development of a positive academic self-concept and can be experienced to make STEM their favourite field.

5.2 Comparative Analysis

Following is Table 2 which shows the comparative analysis between the variables of the study.

Table 2 - MANOVA result for the effect of independent variables on dependent variables

Variables	M	SD	F	p	Observed Power
1. Stem Confidence	2.46	0.74	1.048	0.42	0.82
2. Academic Support	2.2	0.54	1.021	0.46	0.67
3. Social Support	2.6	0.86	1.708	0.97	0.37
4. Learning Enviroment	2.44	0.77	1.584	0.62	0.44

The statistical test in SPSS MANOVA was then conducted, which indicated a high statistical significance between the variables on Social Support in STEM Confidence and Learning Environment. However, Academic Support for STEM Confidence was seen as significant whereas the Learning Environment was also significant. The value of F for Social Support for STEM Confidence was observed as 1.708 ($F(1, 64) = 1.708$, $p = 0.97$, Observed Power = .37) and for Learning Environment, it is seen to be ($F(1, 64) = 1.584$, $p = 0.62$, Observed Power = .44).
Similarly, for Academic Support in STEM Confidence F value was shown as ($F(1, 64) = 1.048$, $p = 0.42$, Observed Power = .82), and for Learning Environment, it is seen to be ($F(1, 64) = 1.021$, $p = 0.46$, Observed Power = .67) indicating a non-statistical difference. The result specified that there is a positive statistical association between STEM confidence and the social and academic Support of the participants. Possibly it can be observed that the STEM confidence of females can be mutated positively by giving them proper Social and Academic Support, Hence answering the second Research Question. As stated by (Benlahcene et al., 2021), that Social Support requires more than a quantity of friends/family and collective activities. It requires a functional dimension; along with this, it provides both emotional and instrumental Support. Overall it was observed that there is a statistically significant difference between the dependent and independent variables of the study.

Further answering the last research question from the results of the study, it is indicated and also described through the answers to the research questions; it is obvious that social and academic Support can positively impact the STEM confidence of female students. It is clear from the evidence that Social and Academic Support is positively correlated to STEM confidence and Learning Environment in STEM classrooms. Struyf et al. (2019), investigated the correlation between students' engagement and introductory STEM courses and found that professors using collaborative methods and a student-centred approach among students reported a high score in emotional and behavioural engagement in STEM classrooms. This supports the statement that creating a learning environment for students that involve social and academic Support provided by instructors and peers can eventually foster engagement in STEM courses. Furthermore, findings of a research study conducted by (Benlahcene et al., 2021) indicated that an appropriate learning environment specifically designed could promote positive behavioural engagements for engineering courses in students.

6. Conclusion and Future Recommendations

The study sets out to determine the self-perceived challenges that female Engineering Students face in Universities in Pakistan; these challenges determine the fact that females are underrepresented in STEM courses. As shown by the Empirical Evidence in this research study, the STEM confidence of females is positively correlated to the Social support given by Family, Peers, and Instructors. Thus it can be assumed here that socially supporting females in several ways, such as by praising them, morally supporting them and giving them courage can eventually lead to an increase in their STEM confidence. Likewise, the effect of Academic Support is also shown to affect the STEM confidence of Females positively and leads to a good Learning Environment. Therefore based on findings obtained through this study, it can be considered that appropriate Social and Academic Support provided to female Engineering students can make a better learning environment for them and hence can foster their STEM confidence. Providing pertinent Social and Academic Support to female engineering students can hence help eradicate the gender gap created in STEM fields and courses, thus serving as the basis for creating a diverse task force of engineers for the development of the country.

Nonetheless, it is accepted that the current research study has limitations. The study was conducted during the pandemic caused by COVID, which was affecting the world. Due to this situation, the country was in complete lockdown with no access to universities on campus. But it shifted the whole process online, and universities shifted their classes and exams to be taken online. The survey form was also filled out through Google Forms randomly by female participants. For Future research, it is required to include interviews and mixed methods research study along with the questions given in this survey. Data collection through surveys could be more convenient when the lockdown will be eased. Moreover, acquiring information in the form of interviews directly with the female students will also help in finding out other challenges they're experiencing. This might also contribute to overcoming the challenges and might eventually result in gender retention in Engineering fields and STEM courses. Other than that, it will give an in-depth awareness of the challenges that might be self-identified by engineering students in Pakistan.

Moreover, it is recommended to include some other retention methods by conducting interactive seminars and educational talks, including female role models at University or organizational level to provide examples to female students so they can enhance their STEM confidence and skills. Female role models serving as an example for female students will also help the students learn from their experiences throughout their journeys in engineering careers. At the institutional level, it is suggested that Instructors and other faculty members should encourage female participation and inclusion in STEM courses concentrating on making them confident in STEM and changing the thought that engineering is just a manly discipline (Makarova et al., 2019), hence in the contemplation get better societies. This can also include Mental Makeup seminars by instructors or alums working in the field. Further, it can also be studied to empirically prove the effect of social and academic support on the academic presentation of female students in STEM.

Ethical Considerations

The study conforms to the ethical Research guidelines. Ethical considerations included proper official permissions, which were taken and approved by the Institute to involve the research participants from different universities. Students who were approached online via email contacts participated through proper channels and volunteered for the data. Individual students' identities and demographics were kept confidential only keeping in view by analyzing the overall scores of the study results.

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