Investigating the Readiness and Challenges female teachers face for Stem Education at the Elementary Level in South Punjab

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Abstract: This research reviewed the preparedness level and obstacles confronted by 291 female elementary school teachers in South Punjab, Pakistan, to enhance STEM education (science, technology, engineering, and mathematics). This cross-sectional study, which used quantitative surveys and qualitative interviews, established a moderate level of STEM readiness and content knowledge comprehension among the participants and teachers. Nonetheless, some major concerns were highlighted, including lack of professional development, Lack of resources, cultural barriers, and limitations to the curriculum. The qualitative data emphasized the necessity for more training opportunities, improved resource distribution, mentorship programs, and greater community involvement to tackle these issues. The study raises the acute awareness of the various challenges, which, if well understood, will assist in implementing STEM education in the region. Among those, there is more focus on professional development, resources, mentors, and strengthening the community for girls in STEM subjects. Thus, by identifying significant factors that affect readiness and main challenges among female teachers, the study contributes to envisioning specific approaches and mechanisms for educators' encouragement and creating a more inclusive STEM education context in South Punjab and other similar areas.

Keywords: STEM Education, Female teachers, Readiness, Challenges, Elementary Level

1. Introduction

As the world enters the twenty-first century, the advancement of technology and implementation of STEM, specifically science, technology, engineering, and math, have become indispensable tools for learning institutions. The role of STEM education is crucial for its potential to prepare students for the world that has been progressing rapidly within the last decades and is necessary for the further development of society (National Research Council, 2011). One more advantage of STEM introduction at the elementary level is that students become interested in subjects related to STEM fields. Thus, encouraging STEM subjects as early as possible also allows focus on the studentsto keep on learning modern information and gaining new knowledge in STEM subjects. Promoting an optimistic attitude toward STEM subjects early on increases the likelihood that students will sustain their curiosity and continue their studies (Archer et al., 2010; Sadler et al., 2012; Qureshi et al., 2023). Furthermore, it is also essential that the early years of a learner's academic years are spent on STEM education as this sets good ground for developing the possession of skills and conceptual knowledge (Ong et al., 2024). Researchers have found that encouraging students, especially junior ones, to be involved in inquiries can help enhance their problem-solving

skills, critical thinking, reasoning, and analytical abilities (Bybee, 2010; Tabbasam et al., 2023; Tabassum et al., 2024).

South Punjab is a more diversified region of Pakistan and is the best place to introduce STEM subjects initially to students of elementary-level classes. It has districts like Multan, Rahimyar Khan, Dera Ghazi Khan,Layyah, Muzaffargarh, and Bahawalpur; the region is set apart by different socio-economic, cultural, and educational milieus (Saeed & Mahmood, 2002). Further, South Punjab has been a socially and politically deprived part of the province. It has been neglected regarding resources and developmental activities by both provincial and federal governments (Amjad et al., 2020, 2021, 2022, a, b; Javid&Iqbal, 2019). This marginalization has dramatically affected the education sector in the region, making it even harder to implement new ideas such as STEM education for students(Mahmood & Idrees, 2017).Additionally, the cultural inclination towards conventional careers such as farming and animal breeding might influence the perception and attitude toward STEM learning (Arif, 2003; Malik et al., 2014). For such reasons, STEM disciplines in some networks may be perceived as irrelevant to their daily and future survival livelihood operations, thus hampering the support and promotion of STEM education at the elementary level. Moreover, it has been revealed that South Punjab suffers chronic forms of inadequate and ineffectively delivered education due to such factors as outdated curricula, routinized teaching methods and approaches, and inadequate emphasis and focus directed toward practical learning practices (Idara-e-Taleem-o-Aagahi, 2015; Mahmood&Idrees, 2017). Sucha kind of learning concept might not be aligned with the learner-centred, project-based, or inquiry-based model of learning usually associated with STEM education. Sucha traditional approach to education may be at odds with the inquiry-based and experiential learning methods commonly linked to effective STEM education. (Bybee, 2010; Honey et al., 2014; Shafqat & Amjad, 2024). Another big problem is the restricted possibility of teachers' professional development, especially in rural regions (Mahmood&Idrees, 2017; Saeed&Mahmood, 2002). Insufficient training may cause teachers not to have adequate knowledge and experience in integrating STEM into learning. Further, there are challenges regarding gender discrimination and social inequities that the education system in South Punjab faces(Idara-e-Taleem-o-Aagahi, 2015). Certain cultural and other beliefs in given cultures canlimit the chances of girls accessing education, which is significantly higher. This gender gap in education can significantly influence the achievement of STEM education, which aims to provide equal opportunities to all students, including females.

Therefore, addressing these problems related to education in South Punjab requires a multi-faceted approach that addresses social, economic, cultural, and infrastructure issues. It is a measure of understanding that joint efforts by the Government, schools, and the general public are central to enhancing the quality of learning and the overall favourable execution of STEM education programs (Amjad et al., 2023, a, b, c). It is only when stakeholders acknowledge that South Punjab is a distinct region in this regard that they can plan and provide strategies and interventions that appropriately address STEM education needs for the population in the region.

1.1 Objectives of the Study
The key aim of this research is to inspect how well the female teachers in South Punjab are equipped to introduce STEM education at the primary school level and to reveal the obstacles they come across when integrating STEM curricula into their teaching practices. The study is particularly interested in determining the following:
1. To evaluate women teachers' preparedness in the South Punjab to implement STEM education initiatives.
2. Identifying the challenges women teachers face when incorporating STEM programs into their classrooms is crucial.
3. Investigating methods and resources to enhance the preparedness and proficiency of women teachers in delivering quality STEM education.

1.2 Research Questions
This research seeks to explore the following inquiries.
1. How prepared are women teachers in South Punjab to introduce STEM education at the elementary school level?
2. What difficulties and barriers are teachers in the South Punjab encountering when incorporating STEM programs of study into their classrooms?
3. How can we enhance the preparedness and skills of women teachers in South Punjab to effectively teach STEM subjects, and what methods and assistance can be implemented to support them in this endeavour?

2. Literature Review

STEM education equips students with the skills and knowledge to thrive in today's job market and tackle intricate issues effectively.The National Science Foundation (NSF) underscores the role of STEM education in promoting innovation and addressing pressing issues like climate change sustainability and healthcare advancements. In addition, STEM education nurtures critical thinking abilities, problem-solving skills, and analytical capabilities that are highly beneficial across career fields and industrial sectors. Pakistan's landscape and government policies highlight the importance of STEM education initiatives the Higher Education Commission (HEC) actively promotes. Students are encouraged to explore STEM fields through programs and initiatives supported by the HEC(HEC, 2017). At primary school levels, in resource-constrained areas still face obstacles when trying to introduce STEM education programs despite the importance of teachers' educational backgrounds; in preparing for STEM teaching roles, according to Nadelson et al., 2013,it is observed that teachers who have undergone comprehensive STEM training during their initial teacher training are more inclined to feel self-assured and adequately equipped to deliver these subjects effectively.Female teachers might not have been exposed to STEM subjects during their training programs; this lack of familiarity could hinder their effectiveness in delivering top-notch STEM education (Amjad et al., 2024, a, b, c; Radloff & Guzey, 2016). STEM encompasses science, technology, engineering, and mathematics and is seen as a method of learning and growth that equips students with problem-solving skills. STEM education provides information, nurtures thinking skills, and enhances comprehension of concepts while cultivating a new wave of creative problem solvers for the future (White, 2014).
In the past, identified as Science, Technology, Engineering, and Mathematics (STEM), the National Science Foundation (NSF) established the STEM program. The primary aim of this endeavour was to motivate students to think critically, helping them tackle challenges and ultimately improving their chances of finding employment. According to Butz and colleagues (2004), there is a belief that students participating in STEM education from kindergarten through 12th grade will gain advantages regardless of their future academic or career paths. Especially if they opt to focus on a STEM-related field of study. Throughout history, different industries, like the era and with inventors such as Thomas Edison, have used STEM principles; however, they have not typically been integrated into conventional educational environments, as highlighted by White (2014). STEM concepts were mainly used in engineering companies to fuel groundbreaking advancements such as lighting systems and vehicles, and they also drove various devices and machinery inventions.The innovators responsible for these progressions often possessed secondary-level education. They participated in training initiatives.

2.1 The Importance of Early STEM Education
Education in Science, Technology, Engineering, and Mathematics (STEM) during school is crucial for laying the groundwork in these disciplines and fostering curiosity and involvement from a young age, according to studies (Archer et al., 2010). Children's perspectives on subjects are shaped during elementary school (Maltese & Tai, 2011). During these years, encounters with STEM subjects and activities can significantly influence their academic paths and career decisions. Early education in STEM is vital for tackling gender gaps in these fields since prejudices and preconceptions can develop during childhood.

2.2 The Role of Families and Communities
The educational system plays a role in encouraging STEM education; however, the participation of families and communities is also essential for its success, as stated in some previous studies. The support and beliefs of parents can significantly influence their children's enthusiasm and involvement in STEM topics. Encouraging activities related to STEM fields and promoting an outlook toward these subjects can impact a child's learning experience(Amjad & Malik, 2024; Dabney et al., 2016). Furthermore, engaging in STEM activities through community groups, museums, and extracurricular programs can offer learning experiences for students and educators.

3. Research Methodology
The researcher created a survey after examining related literature and aligning it with the study's goals.It gathered details like age, name, school name, urban or rural setting, aptitude, expertise, professional training, income, and marital status. The objective of the personal questionnaire in pilot research was to gain insight intothe reception of questions concerning participants' demographic information.The pilot research showed that participants correctly filled out the demographic questionnaire. A readiness scale and a semi-structured interview were used to evaluate elementary school teachers' preparedness and challenges in STEM education. The interview that was conducted

was semi-structured and consisted of 14 questions. These tools and the self-reported demographic data assessed teachers' challenges and readiness. The readiness scale had 49 components in total.

3.1 Population and sample size
The study was conducted among the districts Multan, Vehari, and Muzaffargarh, and the sample selected was from these regions. It comprised only 291 female elementary school instructors, who were purposively randomly sampled. These teachers had teaching experience ranging from 5 to twenty years.

4. Data Analysis
The researcher also did not include any surveys the respondents did not complete. After accumulating all the data, it was compiled and analyzed using a Statistical software program called SPSS version 2013. All studies and sample demographics of all cross-sectional studies were summarized using descriptive statistical data analysis. The reliability of the scales and subscales was assessed by examining internal consistency. An Independent Samples T-test was applied to observe the teachers' level of agreement with their working conditions.

The current study aims to inspect the preparedness and prominent issues that women teachers have in teaching STEM education at the elementary school level in the South Punjab area.

Table 1: Participant Demographic Information

Variable Residential	N	Percentage (%)
Rural	173	59.9
Urban	118	40.5
Age between 21-30	85	29.2
Age between 31-40	125	43.0
Age between 41-50	59	20.3
Age 51 or above	22	7.6
Bachelor's degree	126	43.3
Master's degree	123	42.3
Duration of Teaching:1-5 years	103	35.4
Duration of Teaching:6-10 years	98	33.7
Duration of Teaching:11-15 years	55	18.9
Duration of Teaching Experience:16+ years	35	12.0
Received STEM Training	147	50.5
No STEM Training	144	49.5

Participant characteristics: Table 1 summarizes participants' geographical location, age, educational level, teaching experience, and STEM training conducted.

Table 2: Summary Statistics for Likert Scale Items

Item	Mean	SD
1-Understanding of STEM concepts	3.8	0.9
2-Confidence in teaching STEM subjects	3.6	1.0
3-Access to resources	2.9	1.1
4-Regular incorporation of hands-on activities	3.3	1.1
5-Support from school administration	3.1	1.2
6-Challenges in managing time	3.7	1.0
7-Need for more professional development	4.1	0.9
8-Belief in the importance of STEM education	4.4	0.7
9-Motivation to improve STEM teaching practices	4.2	0.8
10-Openness to collaborating with other teachers	4.0	0.9
11-Satisfaction with educational background	3.5	1.0
12-Satisfaction with knowledge of various STEM	3.7	0.9

disciplines		
13-Satisfaction with curriculum and learning materials	3.0	1.1
14-Satisfaction with classroom and lab resources	2.8	1.2
15-Satisfaction with support and guidance from administrators	3.2	1.1
16-Satisfaction with collaboration opportunities	3.4	1.0
17-Struggles with teaching STEM topics	3.5	1.0
18-Satisfaction with methods to assess students' understanding	3.3	1.1
19-Satisfaction with promoting girls' interest in STEM	3.8	0.9
20-Satisfaction with addressing cultural barriers	3.2	1.1
21-Satisfaction with integrating technology in STEM teaching	3.6	1.0
22-Satisfaction with professional development opportunities	3.7	1.0
23-Satisfaction with addressing students' misconceptions	3.5	1.0
24-Satisfaction with encouraging STEM competitions	3.4	1.0
25-Satisfaction with collaborating with STEM professionals	3.3	1.1

Table 2 presents the graphic statistics, including the mean and the SD for the different rating scale questions adopted in the research study. Such questions address different facets of STEM education, and the answers reveal participants' perceptions, practices, and satisfaction. Overall, Table 2 comprehensively analyzes the participants' experience, attitudes, attitudes, and concerns related to STEM education. These are qualitative useful in understanding the state of play of STEM education and, where possible, looking for more help or resources in creating better STEM education programs.

Table 3: Correlation Between factors

Variable 1	Variable 2	Correlation coefficient
Professional Development of STEM Education	Self-efficacy	0.62
Traditional Roles of Gender	Willingness to Promote STEM	-0.47
Access to the Resources related to STEM Education	Perceived Readiness and Confidence of Teacher	0.54
Educational Qualifications of the Teachers	Pedagogical Content Knowledge	0.58
Peer Support Networks	Self-efficacy and Motivation	0.61

Table 3 depicts correlation coefficients between different variables analyzed in the study. The correlation coefficient measures the strength and direction of the linear relationship between two variables, which varies between -1 and +1. A coefficient of -1 signifies a perfect negative relationship, 0 means no, and 1 depicts a perfect positive relationship.

Table 4: Regression Analysis Results

Predictor	Outcome	Beta	p-value
Development of STEM education for professionals	Self-efficacy	0.45	<0.001
Access to the Resources of STEM Education	Perceived Readiness of STEM Education	0.42	<0.001

Teachers' educational qualifications	Pedagogical Knowledge	Content	0.50	<0.001
Colleague Support Networks	Motivation		0.48	<0.001

Table 4 provides findings on the regression analysis, a statistical tool used to test the hypothesized relationship between the predictor factors and outcome variables. The table is organized into four sections. When creating the variables, words like "Forecasting," "Result," "Beta," and "p-value" were used.

4.1 Qualitative Results Analysis
Since this form of data is acquired through the administration of an open-ended section of the study questionnaire, thematic analyses will be used to analyze the data for patterns and themes. The following section presents the qualitative findings about the research inquiries in a structured format.

Research Question 1: How prepared are the women teachers in the South Punjab area to teach STEM education at the elementary school level?

Table 5: Themes Associated with Readiness Concerning STEM Education

Theme	Frequency (N=291)	Percentage (%)
Essential Understanding Regarding the STEM Education	215	73.9
Confidence at a moderate level	178	61.2
Require further Training	243	83.5
Insufficient resources	196	67.4

Table 5 states themes that developed from the information concerning the preparedness of women teachers in South Punjab to implement an Elementary school education emphasizing STEM. The table contains three columns: theme, Frequency (n=291), and Percentage (%).

Research Question 2: What are the major pitfalls that impede the practice of women teachers from South Punjabin implementing STEM curricula in the classrooms?

Table 6: Themes Concerning Difficulties in STEM Education

Theme	Frequency (N=291)	Percentage (%)
Professional Development was lacking	233	80.1
Societal and Cultural Barriers	182	62.5
Limited Access to the Technology	204	70.1
Curriculum Constraints	189	64.9

Table 6 shows the emergent themes from the qualitative data on critical issues faced by female teachers in South Punjab who are not implementing STEM schemes in their respective classrooms. This table has three columns, with the headings Theme, Frequency (n=291), and Percentage (%), respectively.

Research Question 3: Whichtactics and supports can be developed to improve the preparedness and capability of women teachers in the South Punjab area to bring high-quality STEM education?

Table 7: Themes Concerning Strategies and Support Mechanisms for STEM Education

Theme	Frequency (n=291)	Percentage (%)
Enhanced Professional Development	259	89.0
Improved Resource Allocation	221	75.9

Mentoring Programs	195	67.0
Community and Parental involvement	179	61.5

Table no. 7 above displays the findings in the qualitative data. It explores the various tactics and support services that can be applied to increase the preparedness and ability of the women teachers in the South Punjab area to provide quality STEM education by highlighting the themes identified in the qualitative findings. The table depicts three columns: Theme, Frequency (n=291), and Percentage (%).

4.2 Graphical Representation
Graph 1: Readiness Themes Frequency
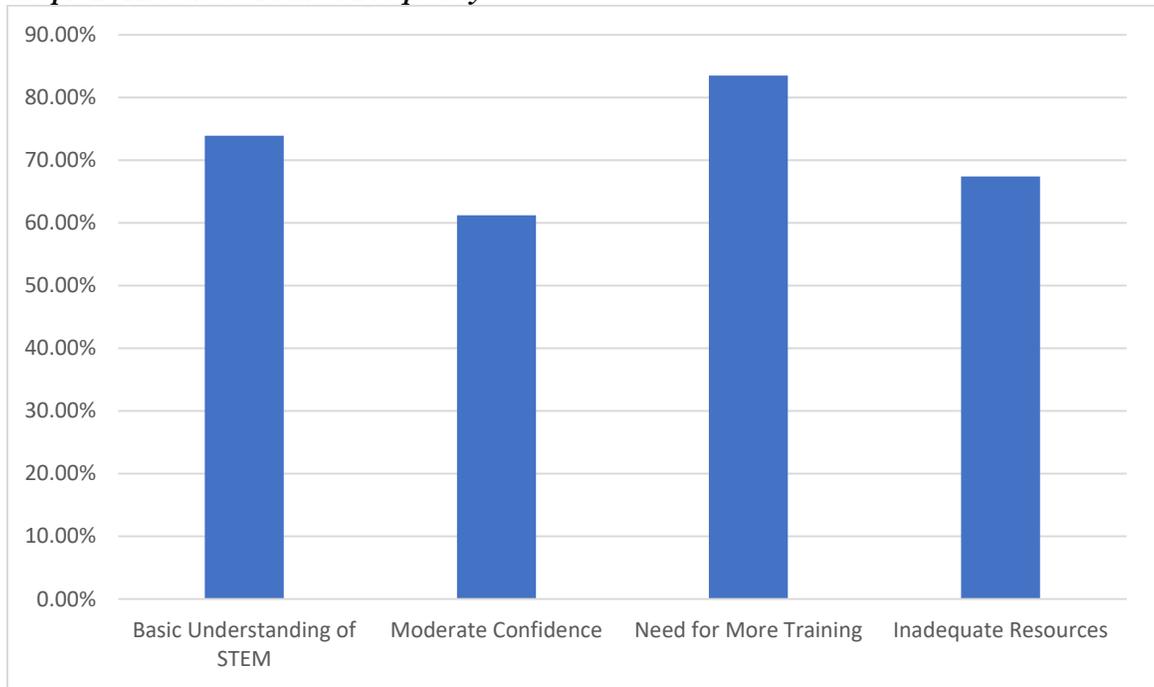
The graph is given in Bar chart format, with frequency or counts on the y-axis (vertically) and Themes on the x-axis (horizontally).

The chart provides a precise and concise summary of the qualitative data, helping to interpret it. It also highlights the key areas where steps need to be taken to prepare female teachers to implement STEM education at the elementary school level in the South Punjab area.

Graph2: Challenges Themes Frequency
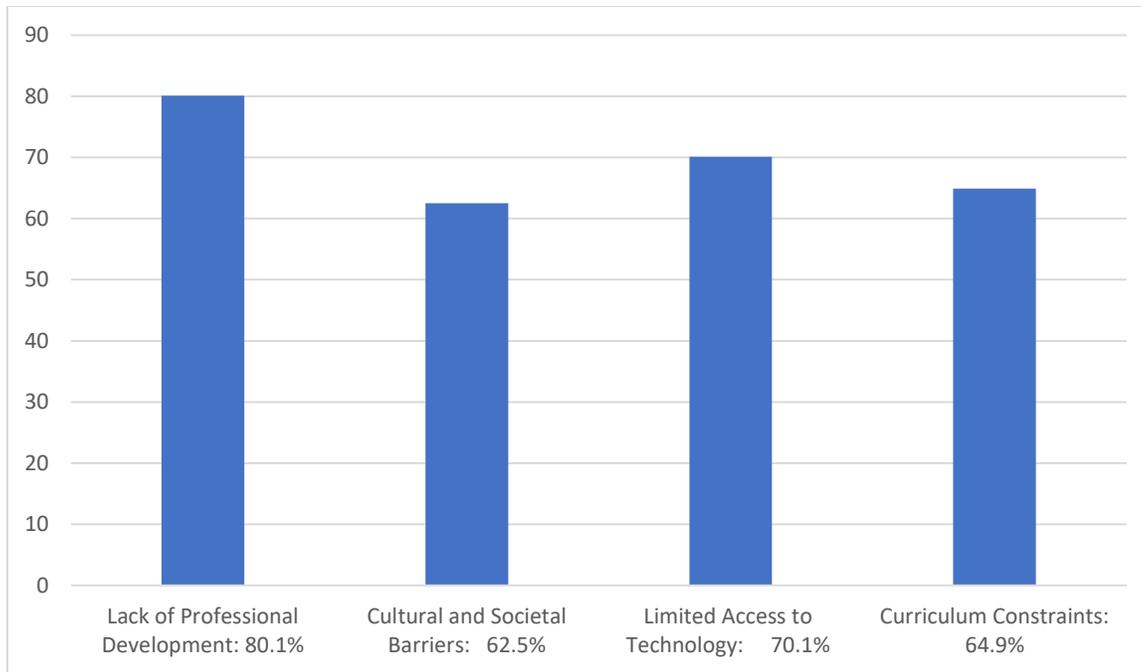
This graphical representation shows simple and compact information that makes it easy to interpret the qualitative data. It highlights the main problems that need to be solved to increase women teachers' capability to include STEM courses in their schoolrooms in the South Punjab.

Graph 3: *Supports and Strategies Mechanism Frequency*
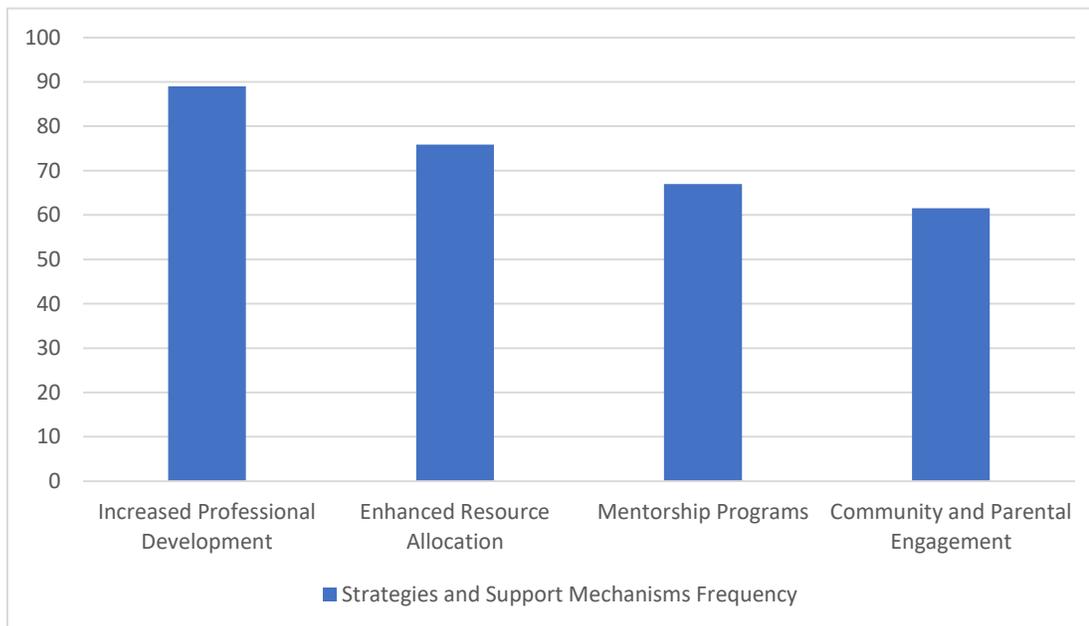
This graph representation approach summarizes the qualitative data tactics and support mechanisms that must be implemented to improve women teachers' readiness and effectiveness in bringing STEM education to the learners in South Punjab.

4.3 Summary

The study thoroughly examines how South Punjab teachers implement STEM education and sheds light on their challenges and opportunities. The data analysis provides a look at the level of preparedness among teachers. Many educators demonstrated an understanding of STEM concepts and moderate confidence; however, the research emphasized the pressing requirement for training and opportunities for professional growth. One significant discovery was the shortage of resources, like supplies, tools, and spaces – which appeared as a significant obstacle to successful STEM education efforts. The qualitative portion of the research provided in-depth perspectives that reinforced and elaborated on the findings. Teachers emphasized a desire for increased opportunities for growth to highlight the significance of continuous learning in this ever-evolving field. They also highlighted the importance of improved resource distribution while recognizing the role of proper tools and materials in hands-on STEM education. The idea of implementing mentorship programs was also crucial for the authors, pointing to the need for peer support and addressing the challenges of STEM teaching. The study identified difficulties that were not restricted to problems of scarcity of resources. Cultural and societal factors were identified as significant barriers to promoting STEM education among girls and girls. This has a profound implication and demonstrates how education and the other aspects of society complement each other, while a multiplier approach is needed that tackles not only the teaching and learning activities inside the classroom but also the perceptions in society. Moreover, foremost barriers, including rigid curriculum and inadequate access to technology, were cited, showing that the problems encountered by educators are indeed systemic. The study results complement the findings of various research done in the context of STEM education. Cultural and societal barriers are recognized to reflect current debates about gender differences in STEM education, and South Punjab's context-specific findings are helpful in the present discussion. Further, the correlation analysis and simple linear regression models supported the statistical significance of each factor of teachers' preparedness, confidence, and interest in STEM education. An analysis of the quantitative data supports the qualitative findings wherein there is a positive relationship between professional development and self-efficacy and a predictive relationship between the availability of resources and perceived readiness. The outcomes of these studies provide sound empirical support for policy suggestions and intervention approaches.

4.4 Findings

The conclusion from this research could be valuable in understanding the preparedness, issue, and availability of resources for South Punjab female teachers to apply elementary-level STEM education. The quantitative data revealed that while the teachers seemed to have a basic knowledge of the STEM area and moderate perceptions, there was a significant need to improve their knowledge and practice through more training and professional development programs. Furthermore, the problem of the availability of limited or inadequate numbers of critical resources, including materials, equipment, and facilities, was highlighted as a significant challenge to the delivery of STEM education.

These findings were also backed up by the qualitative data, which demonstrated the teachers' desire for more professional development, more equitable distribution of resources, and the development of a mentorship program. Different challenges teachers faced were not only the lack of training and materials but also cultural and social issues that impeded girls from opting for STEM education. Further, rigidity in curriculum and restriction of the use of technology were cited as hindrances in giving efficacious STEM curricula.

The study's findings support well-documented prior works that underlined the significance of professional development and resources and support essential to master readiness and confidence among teachers in STEM education. In addition, the cultural and societal barriers identified in the present research correspond to previous investigations on gender disparities and prejudices in STEM disciplines. Descriptive, correlation, and regression analyses also helped elucidate further the relationships between various parameters and the teachers' readiness, confidence, and motivation to teach STEM.For instance, the positive relationship between professional development and self-efficacy and the predictive relation between available resources and perceived readiness for STEM teaching can be used to argue about the importance of those factors in preparing teachers to teach STEM subjects effectively.

In conclusion, this research can be considered a valuable contribution to developing practical, meaningful knowledge in STEM education implementation, as there iscurrently a lack of similar studies in the South Punjab region. The results highlight the need for comprehensive strategies that concentrate more on professional development and resource delivery instead of focusing on the societal and cultural factors that might pose a barrier to implementing STEM curricula.

4.5 Results
The research intended to assess the preparedness and difficulties encountered by 291 female elementary school teachers in effectively implementing STEM (Science, Technology, Engineering, and Mathematics) education in South Punjab, Pakistan. The combination of quantitative surveys and interview studies showed moderate teacher readiness and understanding of STEM concepts. The highlighted challenges include the absence of professional development, inadequate materials, culture and curriculum barriers.

4.6 Discussion
This study can draw conclusions based on female teachers' perceptions of readiness, difficulty level, and local support mechanisms for implementing STEM-based elementary-level education in South Punjab. Quantitative data showed that many teachers claimed to have basic content knowledge and moderate self-efficacy; nevertheless, teacher participants called for more preparation and professional learning. The respondents also felt that materials, equipment, and facilities were deficient among the challenges for the effective implementation of STEM education.

5. Conclusion
It is imperative to acknowledge that this work has several limitations, but it should be valuable for the following reasons. First of all, it is essential to note that due to the massive dimensions of the sample, it could be limited to only female instructors from South Punjab. This limitation also affects the ability to generalize findings on other related places or circumstances. Furthermore, it was based on the teachers' self-reports, which could be affected by biases or popularity bias. It is also worth mentioning that the cross-sectional research design limits the study. Although the results present a relatively comprehensive picture of the present, they do not give an idea of the dynamic and diverse nature of STEM curriculum implementation. As mentioned before, longitudinal studies can provide even more comprehensive insight into the residual effects of treatments and ongoing changes in STEM education. Also, the study essentially focused on the perception of the teachers. To gain a broader perspective on the challenges and opportunities in STEM education implementation, including the perspectives of other customers, such as pupils, parents, and administrators, would be informative.

References

Amjad, A. I., Arshad, L., & Saleem, Z. (2024). Mediational Effect of Students' Creativity on the Relationship between Leadership on Academic Success: Well-Being as Moderator. *Educational Research and Innovation (ERI)*, *4*(1), 1–23. https://doi.org/10.61866/eri.v4i1.60

Amjad, A. I., Aslam, S., & Hamedani, S. S. (2024). Exploring Structural Injustices in School Education: A Study on Intergenerational Repair. In *Frontiers in Education* (Vol. 9, p. 1395069). Frontiers.https://doi.org/10.3389/feduc.2024.1395069

Amjad, A. I., Aslam, S., & Tabassum, U. (2024). Tech-infused classrooms: A comprehensive study on the interplay of mobile learning, ChatGPT and social media in academic attainment. *European Journal of Education*, e12625. https://doi.org/10.1111/EJED.12625

Amjad, A. I., Batool, N., & Tabassum, U. (2023). Modulating inclusive education in early childhood: The role of teachers' attitude and self-efficacy in shaping their awareness and readiness. *Journal of Early Childhood Care and Education, 7*(2), 55-76. https://doi.org/10.30971/jecce.v7i1.886

Amjad, A. I., Habib, M., & Saeed, M. (2022). Effect of brain-based learning on students' mathematics performance at the elementary level. *Pakistan Journal of Social Research*, *4*(03), 38-51. https://doi.org/10.52567/pjsr.v4i03.684

Amjad, A. I., Habib, M., & Tabbasam, U. (2024). Effect of Brain-Based Learning on Students' Extrinsic Motivation to Learn Mathematics: Introducing Neuroscience to Schools. *Journal of Sustainable Education1*(1), 1-12.https://journals.uol.edu.pk/jse/article/view/2617

Amjad, A. I., Habib, M., Tabbasam, U., Alvi, G. F., Taseer, N. A., & Noreen, I. (2023). The impact of brain-

based learning on students' intrinsic motivation to learn and perform in mathematics: A neuroscientific study in school psychology. *International Electronic Journal of Elementary Education*, *16*(1), 111–122. https://doi.org/10.26822/iejee.2023.318

Amjad, A. I., Iqbal, H., & Manzar-Abbas, S. S. (2020). Teachers' awareness about inclusive education in Punjab: A descriptive enquiry. *Journal of Inclusive Education*, *4*(1), 161-178. http://journal.aiou.edu.pk/journal1/index.php/JIE/article/view/419/106

Amjad, A. I., Ishaque, M. M., & Rafique, M. U. (2023). Unravelling the psychological underpinnings of classroom dynamics: A study on teacher-student interaction. *Journal of Development and Social Sciences*, *4*(3), 239–250. https://doi.org/10.47205/jdss.2023(4-III)24

Amjad, A. I., Malik, M. A., & Tabassum, U. (2021). Ready to accept? Investigating Pakistani school teachers' readiness for inclusive education. *Turkish Online Journal of Qualitative Inquiry*, *12*(9). 7442-7456.

Amjad, A. I., Tabassum, U., & Habib, M. (2023). Uncovering teachers' concerns and multi-dimensional attitude towards inclusive education: Who's included and who's excluded. *Journal of Contemporary Trends and Issues in Education, 3*(1), 1-22. https://doi.org/10.55628/jctie.v3i1.71

Amjad, A. I., Tabbasam, U., & Abbas, N. (2022). The effect of brain-based learning on students' self-efficacy to learn and perform mathematics: Implication of Neuroscience into school psychology. *Pakistan Languages and Humanities Review, 6*(3), 683-695. http://doi.org/10.47205/plhr.2022(6-III)60

Amjad, A. I., Tabbasam, U., & Ara, N. (2022). Neuroscientific study on the effect of brain-based learning on students' intrinsic motivation to learn mathematics. *Annals of Human and Social Sciences, 3*(2), 728-742. https://doi.org/10.35484/ahss.2022(3-II)69

Amjad, A.I. & Malik, M.A. (2024).Interviewing students with special needs: Developing ethical considerations and interviewing protocols. Journal of Research in Special Educational Needs, 00, 1–14. Available from: https://doi.org/10.1111/1471-3802.1270

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2010). "Doing" science versus "being" a scientist: Examining 10/11-year-old schoolchildren's constructions of science through the lens of identity. *Science Education, 94(4), 617-639.*https://doi.org/10.1002/sce.20399

Arif, G. M. (2003). Urbanization in Pakistan: A demographic perspective. *The Pakistan Development Review, 42(4), 335-372*

Butz, W. P., Bloom, G. A., Gross, M. E., Kelly, T. K., Kofner, A., &Rippen, H. E. (2004). *Is there a shortage of scientists and engineers? How would we know?* RAND Science and Technology Policy Institute.

Bybee, R. W. (2010). Advancing STEM education: A 2020 vision. *Technology and Engineering Teacher, 70(1), 30-35.*

Dabney, K. P., Tai, R. H., Almarode, J. T., Miller-Friedmann, J. L., Sonnert, G., Sadler, P. M., &Hazari, Z. (2012). Out-of-school time science activities and their association with career interest in STEM. *International Journal of Science Education, Part B, 2(1), 63-79.*

Higher Education Commission of Pakistan.(2017*). STEM education in Pakistan.* https://www.hec.gov.pk/english/services/universities/STEM/Pages/default.aspx

Honey, M., Pearson, G., &Schweingruber, A. (Eds.). (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research.* National Academies Press.

Idara-e-Taleem-o-Aagahi.(2015). *Annual Status of Education Report (ASER) – Pakistan 2015.* http://aserpakistan.org/report

Javid, R., &Iqbal, N. (2019). Marginalization of South Punjab: An analysis of socio-political and economic factors. *Pakistan Vision, 20(2), 49-67.*

Mahmood, N., &Idrees, M. (2017). Challenges faced by teachers in implementing STEM education at elementary level in South Punjab, Pakistan. *Journal of Educational Research, 20(2), 33-45.*

Malik, S. J., Nazli, H., & Whitney, E. (2014). Food consumption patterns and implications for poverty reduction in Pakistan. *Pakistan Development Review, 53(2), 121-148.*

Maltese, A. V., & Tai, R. H. (2010). Eyeballs in the fridge: Sources of early interest in science. *International Journal of Science Education, 32(5), 669-685.*

Nadelson, L. S., Callahan, J., Pyke, P., Hay, A., Dance, M., &Pfiester, J. (2013). Teacher STEM perception and preparation: Inquiry-based STEM professional development for elementary teachers. *The Journal of Educational Research, 106(2), 157-168.*

Nadelson, L. S., Seifert, A., Moll, A. J., & Coats, B. (2013). .i-STEM summer institute: An integrated approach to

teacher professional development in STEM.. *Journal of STEM Education, 13(2), 69-83*

National Research Council. (2011). *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics.* National Academies Press.

Ong, D. J., Aslam, S., & Amjad, A. I. (2024). Interactive Tablets: Catalyzing Engaged Science Learning in English Instruction. *World Journal of English Language, 14*(5), 413-423.https://doi.org/10.5430/wjel.v14n5p413

Qureshi, N. S., Iqbal, M. Z., & Amjad, A. I. (2023). Revitalizing Ancient Tales: Unleashing the Impact of Digital Storytelling on Self-Awareness and Transformation of Aspiring Teachers. *Pakistan Social Sciences Review*, *7*(4), 458-471.https://doi.org/10.35484/pssr.2023(7-IV)42

Radloff, J., &Guzey, S. (2016). Investigating preservice STEM teacher conceptions of STEM education. *Journal of Science Education and Technology, 25(5), 759-774.*

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education, 96(3), 411-427.*

Saeed, M., &Mahmood, K. (2002).Assessing the performance of the primary education system in Pakistan. *The Pakistan Development Review, 41(4), 893-912.*

Shafqat, F., & Amjad, A. I. (2024). Examining Students' Perceptions, Experiences, and Ethical Concerns about Using ChatGPT for Academic Support: A Phenomenological Study. *Pakistan Social Sciences Review*, *8*(2), 443–455. https://doi.org/10.35484/pssr.2024(8-II)36

Tabassum, U., Qiang, X., Abbas, J., Amjad, A.I., &Al-Sulaiti, K.I. (2024). Students' help-seeking mediates the relationship between happiness and self-strength: a comparative study on Chinese and Pakistani adolescents, Kybernetes, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/K-09-2023-1706

Tabbasam, U., Amjad, A. I., Ahmed, T., & Qiang, X. (2023). Comparison of self-strength, seeking help and happiness between Pakistani and Chinese adolescents: a positive psychology inquiry. *International Journal of Mental Health Promotion 25*(3), 389-402. https://doi.org/10.32604/ijmhp.2023.024130

White, D. W. (2014). What is STEM education, and why is it important? *Florida Association of Teacher Educators Journal, 1(14), 1-9.*