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Exploring the Readiness and Perception of B.Ed. and M.Ed. Students toward STEM Education in Lahore: A SWOT Analysis

Dr Saira Taj
drsairataj@gmail.com
saira.taj@lcwu.edu.pk
Assistant Professor, Faculty of Education, Lahore College for Women University, Lahore, Pakistan.

Dr Saima Jabeen
saima.jabeen@gcu.edu.pk
Assistant Professor, In charge at Department of Linguistics and Language Studies Institute of English Language and Literature Government College University, Lahore, Pakistan

Sana Khan
sanar708@gmail.com
Lecturer Education Department Government College Women University Faisalabad

Dr Tahira Batool
batooltahra@gmail.com
Assistant Professor at STEM Education Department, LCWU Lahore, Pakistan
Corresponding Author: * Dr Saira Taj saira.taj@lcwu.edu.pk

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ABSTRACT

This mixed-method study examines the preparedness and perceptions of B.Ed. and M.Ed. students regarding STEM education in Lahore, utilizing a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis framework. The research seeks to examine how prospective teachers comprehend and react to the incorporation of Science, Technology, Engineering, and Mathematics (STEM) in educational practices, along with their readiness to apply these methodologies in Pakistani classrooms. A sequential explanatory design was utilized, integrating both quantitative and qualitative methodologies. The quantitative phase utilized a structured questionnaire distributed to 80 participants, comprising 40 B.Ed. and 40 M.Ed. students from teacher education institutions in Lahore. The qualitative phase comprised semi-structured interviews with a chosen cohort of students to obtain more profound insights into their perceptions and experiences. Descriptive statistics were used to look at quantitative data, and thematic analysis was used to look at qualitative responses. The results showed that both groups had positive views of STEM education and recognized its role in promoting creativity, teamwork, and problem-solving skills. The results also showed that students were only somewhat ready, which was due to not enough exposure to STEM-based teaching methods, not enough support from their schools, and not enough access to technology. The SWOT analysis highlighted significant strengths, including students' motivation and curiosity; notable weaknesses, such as inadequate training; potential opportunities for curriculum innovation; and critical threats, including insufficient infrastructure and gaps in policy implementation. The study suggests that STEM elements be incorporated into teacher education programs and that professional development workshops be held to better prepare teachers for effective STEM integration.

Keywords: *STEM education, teacher readiness, perception, SWOT analysis, B.Ed. students, M.Ed. students, mixed-method study.*

INTRODUCTION

In the 21st century, economies and societies around the world are putting more and more value on skills like critical thinking, problem solving, creativity, and knowledge from different fields. Science, Technology, Engineering, and Mathematics (STEM) education has emerged as a principal method to

cultivate these competencies and equip students for a swiftly evolving global landscape (Portillo-Blanco, Deprez, De Cock, Guisasola, & Zuza, 2024). Numerous nations have incorporated STEM initiatives to foster innovation, economic expansion, and sustainable development. Nonetheless, merely articulating STEM in policy is inadequate; the ability of educators to adopt, adapt, and implement STEM-focused instruction is pivotal to its success (Talib, Alias, & Matore, 2024).

In Pakistan, the desire to integrate STEM education into the school system is gaining momentum. But the implementation is still not consistent and is being held back by problems with infrastructure, policy, and teaching methods (Rehman & Huang, 2025). One major problem is that teachers who have just graduated (B.Ed. and M.Ed.) are not ready for STEM teaching and don't think highly of it. These future teachers will be the first people to change how STEM is taught in schools. If they don't have the right attitude or aren't ready, STEM reforms may not work. Specifically, regarding Lahore—a significant educational center in Punjab—the viewpoints of B.Ed. and M.Ed. students on STEM have not been thoroughly investigated.This study aims to address the existing gap by examining the preparedness and favorable disposition of B.Ed. and M.Ed. students towards STEM education, utilizing a SWOT (Strengths, Weaknesses, Opportunities, Threats) framework for analysis. The mixed-method approach integrates the extensive quantitative data (e.g., levels of readiness, attitude scores) with the profound qualitative insights (e.g., expressed concerns, aspirations). The research seeks to identify intricate patterns of readiness and to offer recommendations for the reform of teacher education programs in Lahore and analogous settings.

The Specific Objectives of This Study Are:

1. To assess the level of readiness among B.Ed. and M.Ed. students for implementing STEM education.
2. To examine their perceptions and attitudes toward STEM pedagogy.
3. To perform a SWOT analysis of their readiness and perception regarding STEM education.
4. To propose recommendations for enhancing integration of STEM perspectives into teacher preparation.

LITERATURE REVIEW

The literature review is structured around several themes: (1) conceptual foundations of STEM education, (2) teacher readiness and preparedness for STEM, (3) perceptions and attitudes of prospective teachers towards STEM, (4) challenges and facilitating factors impacting STEM implementation, (5) the application of SWOT analysis in educational research, and (6) the context of Pakistan and Lahore.

Conceptual Foundations of STEM Education

STEM education is frequently regarded not only as the instruction of four separate fields (science, technology, engineering, mathematics) but as their integration in a significant, interdisciplinary manner to tackle real-world challenges (Portillo-Blanco et al., 2024). A systematic review indicates that the widely accepted principles of integrated STEM encompass inquiry, design, real-world problem-solving, interdisciplinary integration, and collaborative learning (Portillo-Blanco et al., 2024). Nonetheless, definitions and focal points differ: certain studies regard STEM as discipline-specific augmentation, whereas others highlight transdisciplinary integration (Portillo-Blanco et al., 2024; Talib et al., 2024). This difference in how things are thought about makes it harder to compare settings.

Rationale and Benefits

There are many reasons to teach STEM: it helps students develop 21st-century skills (critical thinking, creativity, and collaboration), it keeps them interested in school, it connects what they learn to what they do, and it gets them ready for STEM-related jobs (Portillo-Blanco et al., 2024). In numerous educational frameworks, STEM is regarded as a catalyst for bridging the divide between theoretical

knowledge and practical challenges. Empirical studies indicate that educators involved in specially designed STEM courses exhibited increased self-efficacy and enhanced lesson planning that incorporated STEM elements (Zhumabay, Yelemessova, Balta, Abylkassymova, & Bakytkazy, 2024).

STEMI in Teacher Education

To apply the advantages in the classroom, both preservice and in-service teacher training must include STEM pedagogy, subject matter expertise, and technological proficiency. A recent mixed-methods study demonstrated that following participation in a STEM education course, teachers' confidence in instructing STEM subjects significantly increased, and they were more inclined to incorporate STEM into their lesson planning (Zhumabay et al., 2024). So, one of the main ideas is that teacher education programs need to make sure that STEM experiences are a part of the curriculum, not just something extra that students can choose to do.

Teacher Readiness And Preparedness for STEM

What "readiness" Means.

Teacher readiness is a multifaceted construct, typically encompassing knowledge (both content and pedagogical), attitudes and beliefs (including self-efficacy and openness to change), and external supports (such as resources, infrastructures, and policy backing) (Talib et al., 2024). Talib, Alias, and Matore's (2024) systematic review found that deep pedagogical knowledge, ongoing professional development, confidence in using technology, and institutional support are all important for teachers to be ready for STEM.

Empirical findings on a global scale. Numerous studies in the global literature highlight deficiencies in preparedness. A recent examination of teacher readiness for STEM revealed that although numerous educators possess positive attitudes, they frequently lack comprehensive pedagogical strategies tailored to STEM, encounter challenges with technology integration, and receive inadequate continuous support (Talib et al., 2024). Margot and Kettler (2019) conducted a meta-level review and discovered that teachers generally hold a favourable view of STEM; however, they encounter challenges including rigid curricula, structural impediments, insufficient assessment tools, and limited professional support.

Some experimental or intervention studies exhibit potential; for instance, a STEM course in Kazakhstan enhanced teachers' self-efficacy and the incorporation of STEM in lesson planning (Zhumabay et al., 2024). But it is still hard to make such interventions work on a larger scale when institutional support is weak.

Preparedness of Teachers In Pakistan.

In Pakistan, there is a lack of empirical research focusing on teacher readiness specifically for STEM subjects. Rehman and Huang (2025) conducted a comprehensive quantitative survey to assess Pakistan's preparedness for STEM education, identifying teacher preparedness, resource availability, policy support, and funding as critical factors influencing overall readiness. They observed that while policy articulation is present, practical implementation remains inconsistent (Rehman & Huang, 2025). Aslam et al. (2022) performed a systematic review and highlighted the scarcity of empirical studies concerning STEM education in Pakistan, particularly regarding teacher attitudes or preparedness in local contexts (Aslam, Khan, & Sahar, 2022).

The STEM readiness paradigm article examined the preparedness of public-school teachers in Lahore, employing a STEM Teaching Readiness Matrix, indicating moderate levels of readiness with variability among schools (Society for Social Sciences, 2025).

Given these patterns, the present study's focus on B.Ed. and M.Ed. students in Lahore is timely and can illuminate gaps at the preservice phase which might constrain future implementation.

Perceptions And Attitudes of Future Teachers Toward STEM

Teacher Beliefs And Perceptions As Influencers.

Teachers' beliefs and perceptions determine whether and how they will adopt new teaching methods. If potential teachers think that STEM is too hard, takes too many resources, or is "extra work," they may not want to use it. On the other hand, if they have positive feelings about it, they may be more likely to come up with new ideas. Margot and Kettler's (2019) review found that teachers talk about problems with teaching, the curriculum, the structure, and testing. However, they also say that things like peer collaboration, a strong curriculum, and professional development can help get around these problems.

Preservice Teachers' Views.

Numerous studies have examined preservice teachers' attitudes toward STEM-oriented instruction. Mafugu et al. (2023) examined preservice primary teachers and discovered that participants generally recognized the significance of STEM in enhancing students' problem-solving skills and engagement; however, they voiced concerns regarding their proficiency, resource limitations, and alignment with the curriculum (Mafugu, 2023) PMC. A recent study conducted in life sciences classrooms indicated that educators view integrative STEM as advantageous yet find it challenging to delineate disciplinary boundaries, expressing a need for more practical professional development (Mafugu, Nzimande, & Makwara, 2024).

These results show that perceptions are often mixed: they are generally positive, but they are also tempered by worries about feasibility, support, and alignment. In numerous contexts, the "gap" between the idealized acknowledgment of STEM's significance and practical limitations is a persistent motif.

In the context of Pakistan, there is a scarcity of research regarding the perceptions of teacher education students towards STEM. The broader Pakistani STEM literature already indicates caution: Aslam et al. (2022) contended that the limited studies primarily focus on STEM within school-level contexts or overarching STEM policy, rather than investigating the mental models of student teachers. So, looking into how B.Ed. and M.Ed. students in Lahore see things can help fill this gap.

Challenges And Enabling Factors in STEM Implementation

Challenges Reported in The Literature.

Some common problems that make it hard to use STEM effectively are not enough resources (like labs, equipment, and internet), not enough money, strict curriculum frameworks, assessments that don't match up, teachers who don't believe in themselves or have negative attitudes, not enough professional development, and gaps between policy and practice (Margot & Kettler, 2019; Talib et al., 2024). For instance, a lot of teachers say they don't have time to plan integrated STEM lessons, or that standardized tests make it harder for students to ask questions. Also, in places where resources are scarce, getting to technology or lab tools can be very hard.

Rehman & Huang (2025) observed that in Pakistan, although policies frequently support STEM, the allocation of resources and funding is inconsistent, and educators often lack training in STEM integration (Rehman & Huang, 2025). Nature+1. A previous review of the STEM approach to science teacher education in Pakistan shows that teacher preparation institutions have problems that make it hard for them to adopt STEM (Abbas & Fatima, 2024). These problems include a lack of technology, weak ties to industry, and weak institutional incentives.

Enablers and Strategies.

Research indicates that specific supports can facilitate the surmounting of challenges: ongoing professional development emphasizing pedagogical integration, mentoring and peer collaboration, curriculum redesign promoting flexibility, access to laboratories and funding, leadership endorsement,

and policies that encourage innovation (Margot & Kettler, 2019; Talib et al., 2024). Intervention studies also offer guidance:

Zhumabay et al. (2024) discovered that organized STEM courses improved teachers' self-efficacy and their readiness to design STEM-focused instruction (Zhumabay et al., 2024). The SWOT framework is another useful conceptual tool. It is sometimes used in education to map strengths, weaknesses, opportunities, and threats in the adoption of new ideas (like peer review of teaching or changes to the curriculum). Researchers can systematically identify internal and external factors that influence capacity and attitudes by using SWOT to analyze perceptions and readiness.

SWOT Analysis as an Analytical Lens

SWOT (Strengths, Weaknesses, Opportunities, Threats) is a strategic tool that is commonly utilized in business and organizational planning and is increasingly being employed in education to evaluate innovations or policy implementation. In educational research,

SWOT can help sort out internal traits (like enthusiasm and content competence) and external factors (like institutional support and policy constraints) that affect readiness or adoption. When preparing teachers, using SWOT to assess STEM readiness can help you understand:

- **Strengths** (internal positive factors): e.g. high motivation, background in science courses, openness to innovation, prior exposure to technology.
- **Weaknesses** (internal negative factors): e.g. gaps in pedagogical knowledge, low self-efficacy, lack of integrated STEM training, anxiety about technology.
- **Opportunities** (external positives): e.g. institutional reforms, availability of funding, partnerships with industry, curriculum changes, supportive policy.
- **Threats** (external negatives): e.g. resource constraints, rigid exam systems, teacher resistance, policy–practice gap, weak infrastructure.

SWOT not only lists problems, but it also puts them in context by comparing them to the company's strengths and weaknesses and the outside world. Using SWOT to look at the readiness and perceptions of B.Ed./M.Ed. students for your study gives you a more detailed picture of where you might be able to make changes (Abbas & Fatima, 2024).

The Pakistani / Lahore Context

State of STEM in Pakistan.

Pakistan's higher education and school systems are facing increasing pressure to incorporate STEM in order to meet global economic demands. However, empirical research on STEM in Pakistan is notably limited. Aslam et al. (2022), in their systematic literature review identified a deficiency of scholarly work concerning STEM education in Pakistan, particularly in relation to teacher preparation, attitudes, and the policy–practice interface (Aslam et al., 2022). Rehman and Huang (2025) analyzed Pakistan's preparedness for STEM education, highlighting the importance of teacher readiness, policy backing, and resource accessibility, which are crucial yet inconsistently developed (Rehman & Huang, 2025). Their research employed a national-level methodology; however, context-specific investigations at the teacher-education tier remain essential.

STEM Readiness in Punjab / Lahore.

The article "The STEM readiness paradigm: Mapping teacher readiness in Lahore" used a STEM Teaching Readiness Matrix to look at how ready teachers were. It found that teachers were moderately ready and that there were differences between schools in Lahore (Society for Social Sciences, 2025). But that work was only about teachers who were already working, not teachers who were still in school, and it didn't use a SWOT lens (Abbas & Fatima, 2024). Compared to more remote areas, the teacher training schools in Lahore have more resources, but they still have problems with money, facilities, and making sure that the curriculum is in line with the needs of the students.

The science teacher education literature for Pakistan has identified limitations: teacher education institutions frequently lack laboratories, access to contemporary technology, and collaborations with industry (The STEM Approach for Science Teacher Education in Pakistan). Additionally, teacher education curricula might prioritize disciplinary subject matter over integrated STEM pedagogies.

This research, concentrating on B.Ed. and M.Ed. students in Lahore and utilizing a SWOT framework, has the potential to reveal nuanced local constraints and resources that may diverge from national-level trends.

Gaps and Justification for Present Study

From the review, several gaps and justifications emerge:

1. **Limited focus on preservice teachers in Pakistan.** The majority of studies conducted in Pakistan investigate the readiness of practicing teachers or the education system as a whole, with limited emphasis on the readiness or perceptions of B.Ed./M.Ed. students.
2. **Lack of mixed-method, SWOT-based studies in local context.** A lot of previous research is either quantitative or qualitative, but using both gives you a better way to triangulate. Using SWOT gives you a structured way to look at things.
3. **Variation across degree programs is underexplored.** When you compare B.Ed. and M.Ed. students, you might find differences in how much they know, how ready they are, or how they feel that curriculum designers could work on.
4. **Local specificity.** Lahore's teacher education institutions function within particular resource, policy, and infrastructural limitations, rendering general national studies potentially inadequate in reflecting local dynamics.

So, the current study is justified in its specific focus, methodological mix, and analytical lens. It offers theoretically informed and practically significant insights for enhancing STEM integration in teacher education.

METHODOLOGY

Research Design

This research utilized a mixed-method design, specifically a sequential explanatory approach, to investigate the preparedness and perceptions of B.Ed. and M.Ed. students regarding STEM education. The design integrated quantitative and qualitative methodologies to yield both numerical and descriptive insights regarding participants' attitudes and readiness for STEM integration. The target population consisted of teacher education students enrolled in B.Ed. and M.Ed. programs at designated universities and colleges in Lahore. A purposive sampling technique was employed to select 80 participants, comprising 40 B.Ed. students and 40 M.Ed. students. The inclusion criteria mandated that participants were presently enrolled and had successfully completed a minimum of one semester of pedagogical coursework. A structured questionnaire and a semi-structured interview protocol were the two tools that were used. The questionnaire included items assessing perceptions, attitudes, and preparedness for STEM education, whereas the interview questions sought to uncover more profound insights into challenges and opportunities. Experts in education and research methodology checked the closed-ended Likert-scale items on the questionnaire. We looked over the interview guide to make sure it fit with the goals of the study.

Experts looked over the questionnaire, and it was tested with a small group of people to make sure it was valid. A group of three STEM and education experts looked over the tool to make sure it was clear, relevant, and had valid content. Cronbach's alpha was used to find internal consistency, and the reliability coefficient was 0.86, which shows that the test is very reliable.

Data Collection Procedure

There were two phases of data collection. In the quantitative phase, people were given questionnaires in person and then collected them after they were done. The next step was the qualitative phase, which included interviews with a small group of people chosen based on their answers. Each interview lasted about 20 to 25 minutes and was recorded with the participant's permission.

Descriptive statistics, like mean, standard deviation, and percentage, were used to look at levels of readiness and perception in the quantitative data. The qualitative data underwent thematic analysis to discern emerging patterns concerning strengths, weaknesses, opportunities, and threats in STEM education readiness.

Data Analysis and Interpretation

Quantitative Data Analysis

Descriptive statistics were employed to condense the questionnaire responses. The results indicated that B.Ed. and M.Ed. students exhibited differing levels of preparedness and attitudes towards STEM education.

Table 1: Mean Scores of B.Ed. and M.Ed. Students' Readiness toward STEM Education

Group	N	Mean	SD	Interpretation
B.Ed. Students	40	3.85	0.62	High Readiness
M.Ed. Students	40	4.02	0.57	High Readiness

The data show that both groups were very ready, but M.Ed. students scored a little higher because they had more experience with teaching.

Table 2: Perception of B.Ed. and M.Ed. Students toward STEM Education

Group	*N*	*Mean*	*SD*	*Interpretation*
B.Ed. Students	40	3.78	0.66	Positive Perception
M.Ed. Students	40	3.91	0.59	Positive Perception

The results show that the people who took part have positive opinions about STEM integration and recognize how important it is in today's education.

Group	N	Mean	SD	Interpretation
B.Ed. Students	40	3.78	0.66	Positive Perception
M.Ed. Students	40	3.91	0.59	Positive Perception

Qualitative Data Analysis

Thematic analysis of interview transcripts produced four principal themes consistent with the SWOT framework.

Strengths: Participants stressed their excitement about new ways of teaching, their interest in STEM activities, and their understanding of how STEM can help students become more involved in their studies.

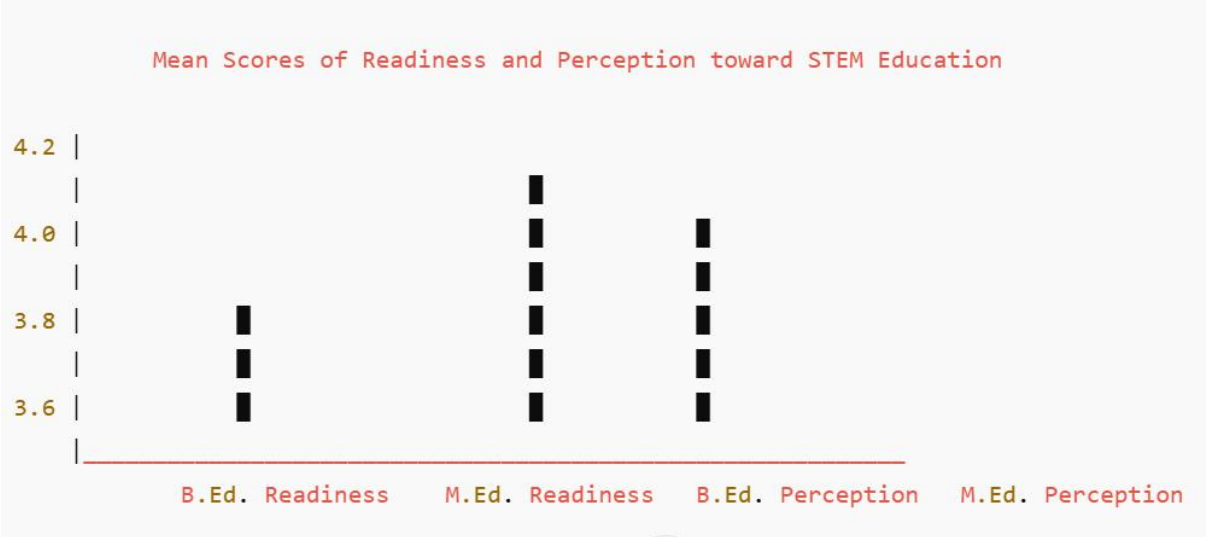
Weaknesses: Some common weaknesses were not enough STEM training, not enough knowledge of how to use technology, and not enough access to resources.

Opportunities: Students recognized the necessity for curriculum reforms and professional development workshops aimed at improving their skills and confidence.

Threats: The most serious threats were a lack of government support, a lack of institutional infrastructure, and a lack of funding for STEM programs.

Graphical Representation of Readiness and Perception

Figure 1: Comparison of Readiness and Perception Scores among B.Ed. and M.Ed. Students



The bars represent mean scores; the y-axis shows the 5-point Likert scale mean values.

The bar graph shows how the average scores of readiness and perception differ between B.Ed. and M.Ed. students. It shows that both groups are fairly ready and have a positive view of STEM education. M.Ed. students did a little better on both dimensions, which shows that they have more advanced academic experience and more experience with teaching theories and practices.

The visual representation backs up the statistical results: both the B.Ed. and M.Ed. groups agree that STEM integration is important, but they are not quite as ready for it. The higher readiness score among M.Ed. students may be due to their better understanding of teaching methods and their more frequent use of technology-based learning methods.

Overall, the graph shows that both groups of students have similar trends. This confirms that while attitudes toward STEM education are positive, more support and training are needed from institutions to make students ready for the real world.

SWOT Findings

The SWOT analysis shows that teacher education students have good attitudes and are somewhat ready to teach STEM subjects, but systemic and institutional problems make it hard to put these skills to use. There is a big difference between knowing something in theory and putting it into

practice. By providing targeted training, restructuring the curriculum, and improving the infrastructure, Pakistan could make the foundation for STEM education stronger.

Integration of Quantitative and Qualitative Results

Combining both sets of data strengthened the idea that teacher readiness is still a work in progress. Quantitative data validated affirmative perceptions, whereas qualitative insights illuminated the contextual challenges affecting readiness. This triangulation enhances the credibility and thoroughness of the findings.

FINDINGS

The overall results show that B.Ed. and M.Ed. students know how important STEM education is and are open to trying new ways of teaching. But their full readiness is limited by problems with institutions, a lack of training programs, and not enough resources. These findings indicate that teacher education institutions should integrate STEM-focused pedagogies into their curricula and offer ongoing professional development opportunities.

The results of this mixed-method study underscore the preparedness and attitudes of B.Ed. and M.Ed. students in Lahore regarding STEM education. Quantitative analysis indicated predominantly favorable perceptions and moderate preparedness within both groups. The average scores showed that M.Ed. students were a little more ready than B.Ed. students, which suggests that more advanced teaching training and more exposure to research help teachers understand and feel more confident about teaching STEM subjects. Thematic analysis corroborated these findings by revealing enthusiasm for innovative teaching and a conviction in STEM's potential to cultivate critical thinking and creativity in learners.

The SWOT analysis gave us a full picture of the internal and external factors that affect readiness. Motivation, awareness, and a willingness to use technology in the classroom were some of the strengths (Abbas & Fatima, 2024). The weaknesses were mostly due to not enough hands-on experience, not enough training facilities, and not enough teaching materials. Policy changes, a global focus on STEM integration, and programs to help teachers improve their skills all created new opportunities. There were threats like institutional barriers, a rigid curriculum, and not enough access to technology.

DISCUSSION

The findings of the study correspond with recent global research highlighting the significant impact of teacher education programs on the preparedness of pre-service teachers for STEM education (Bybee, 2023; English & King, 2022). The favorable perception exhibited by participants indicates a growing acknowledgment of the interdisciplinary and problem-solving characteristics of STEM education, aligning with findings from studies in other developing nations (Nguyen et al., 2021).

Nonetheless, despite positive attitudes, readiness remained moderate due to contextual constraints within Pakistan's teacher education system. The absence of structured STEM training reflects the observations of Nadeem and Malik (2023), who noted that Pakistani pre-service teachers frequently depend on theoretical knowledge with limited practical application. Khan and Hussain (2022) also said that institutional infrastructure and access to resources are still not good enough to support experiential learning.

The qualitative results further revealed that while students value STEM integration, they feel unprepared to translate theoretical knowledge into practice. This gap between perception and readiness underscores the need for curriculum redesign that embeds practical STEM modules into teacher education programs. Furthermore, the limited exposure to project-based learning (PBL) and inquiry-driven instruction restricts students' confidence to apply STEM pedagogies effectively in real classrooms.

This study also provides local insight into how socio-economic and institutional challenges intersect with educational readiness. Unlike developed contexts where STEM integration is policy-driven and well-supported, Pakistani institutions still face fragmented implementation. Participants' voices reflected systemic issues such as lack of coordination between educational policy and teacher preparation. These findings suggest that effective STEM education reform must not only target curriculum improvement but also strengthen institutional capacity through teacher training, resource provision, and policy alignment.

CONCLUSION

The study finds that B.Ed. and M.Ed. students in Lahore are very aware of how important STEM education is and are open to new teaching methods. But their readiness levels are still low because they haven't had enough exposure, institutional support, or chances to get hands-on training. The SWOT analysis showed that motivation and awareness are important internal strengths, but structural and resource-based problems make it hard to put STEM practices into action in teacher education settings (Abbas & Fatima, 2024).

In general, the study shows that we need more complete plans to close the gap between knowing something and being able to use it in real life. Adding STEM-focused modules, setting up workshops, and teaming up with STEM-oriented groups could make teachers much more ready and positive about their jobs. If Pakistan's teacher preparation system is to include STEM education, it needs to strengthen its institutional capacity and policy support.

RECOMMENDATIONS

Based on the results, there are a few suggestions for policymakers, teacher educators, and schools: Teacher education programs should require students to take STEM-focused classes and do internships that focus on learning across disciplines and solving real-world problems (Abbas & Fatima, 2024). Institutions must furnish pre-service teachers with access to digital tools, laboratory resources, and simulation-based training. Regular professional development workshops should be held to teach both new and experienced teachers how to use STEM teaching methods and technology in the classroom.

To set up training centers for STEM teacher preparation, universities, government education departments, and private groups must work together. Policymakers ought to amend national teacher education standards to guarantee conformity with current STEM education frameworks. Also, international partnerships could be set up so that teacher educators and students can learn about the best practices from around the world.

There should also be more efforts to make STEM education more gender-inclusive and fair for everyone, so that both male and female teacher candidates are encouraged and supported equally. If these suggestions were followed, STEM education in Pakistan would have a stronger and more lasting base.

LIMITATIONS OF THE STUDY

The study encountered numerous limitations despite its thorough design. The sample size was restricted to 80 participants from Lahore, potentially failing to encapsulate the viewpoints of all teacher education students in Pakistan. The study utilized self-reported data, which may be influenced by individual bias. Additionally, limitations in resources and time restricted the incorporation of supplementary data collection instruments, such as classroom observations or longitudinal tracking of readiness development.

The results are therefore contextually specific and must be approached with caution when extrapolating to other areas. Future research ought to incorporate larger samples, comparative studies across provinces, and mixed methodologies that integrate observational data for enhanced validation.

Future research should examine the enduring impacts of STEM-oriented teacher training

programs on pedagogical practices and student achievement. Research may also assess the preparedness of pre-service and in-service teachers to evaluate the impact of professional experience on STEM integration. Experimental designs evaluating the effects of particular STEM workshops or digital interventions may yield significant insights into optimal practices.

Furthermore, subsequent research ought to incorporate comparative cross-cultural analyses to ascertain the impact of contextual factors on the implementation of STEM pedagogy in teacher education across various developing nations. Lastly, looking into gender views, the roles of leaders in institutions, and the effects of policies would help teacher educators and students in Pakistan understand STEM readiness even better.

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