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Towards Excellence: Addressing STEM Education Challenges in Karachi's Primary Sector

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ABSTRACT

Numerous nations have recognized STEM education as a cornerstone for economic development, drawing considerable focus from diverse educational systems. However, the practical execution of STEM education has encountered various challenges, particularly in developing Asian countries. This qualitative study examined STEM education challenges in Pakistan's public primary schools. The participants involved in this study were ten primary teachers in Karachi, Pakistan, having 7-20 years of teaching experience. The data was collected through a semi-structured interview approach. Analysis of the interview transcripts revealed that teachers faced numerous challenges, such as teacher training, limited teaching resources, professional development, time limitations, and curriculum design while implementing STEM education. The findings revealed that among all the faced challenges, time limitations and curriculum standards are notable tensions among teachers. The research findings were examined in terms of the regional context and cultural norms. The study examines the implications of STEM education for Pakistan's Primary school contexts and beyond for the teaching methodology and professional growth.

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INTRODUCTION

The study of engineering, science, technology, and mathematics (STEM) is gaining importance worldwide at all educational levels, from kindergarten to tertiary (Anwari et al., 2015; Kennedy & Tunnicliffe, 2022). The competent connection of the four academic fields offers many opportunities to enhance the standard of instruction. STEM subjects may help students become skilled in developing, implementing, and using technology while also applying integrated knowledge to solve learning issues (Farwati et al., 2021). This concept concerns the objectives and policies for reforming subjects and skills and understanding learners in math and science or combining technology and engineering knowledge (Margot & Kettler, 2019). Additionally, educators might use STEM courses as textbooks, learning materials, assessment tools, study planners, learning approaches, and learning methods (Farwati et al., 2021).

However, an integrated technique for teaching and learning generally refers to when the word STEM is used to discuss educational policies and curriculum (Wan et al., 2023). Academic policies and regulations worldwide have placed a significant value on implementation in STEM education to separate the current change in STEM learning from traditional discipline-based education (So et al., 2024). In order to include STEM concepts in instruction, STEM education focuses on the necessity of linking theoretical learning to actual knowledge and issues (Margot & Kettler, 2019). Applying the STEM methodology might improve and positively impact learning outcomes. Proficiency in communication skills may enhance students' learning attitudes and subject matter, enabling them to solve challenging problems with higher-order thinking (Parveen et al., 2022).

The method of connecting multiple STEM areas' equivalent of STEM information to improve student learning by using STEM practices in an actual-world context (Kelley & Knowles, 2016). Teachers must have extensive science, technology, engineering, and mathematics backgrounds to prepare learners in those subjects adequately. However, it was noted that many teachers in Karachi, Pakistan, needed more confidence in genuinely influencing their pupils' passion for STEM jobs at the school level. A new approach that can spark young children's interest in STEM subjects is integrated into STEM learning. However, implementing this new instructional technique is difficult since there is agreement on integrated STEM teaching practices. It is crucial to assist students by making links clear since it might be challenging for them to connect what they know and their skills in other disciplines if they are not strong in those areas (Demir et al., 2021).

The integration of STEM education is full of challenges for many nations worldwide. It is becoming more apparent that teacher education institutes may play a significant part in addressing these issues with STEM education (Ryu et al., 2019). Developing elementary teachers' professional skills to create and follow integrated STEM learning activities is still challenging because they may become closer to implementing an interconnected curriculum than middle school teachers and professionals in one subject area.

STEM education educates outstanding STEM students and enhances their capacity for creativity, an increasingly important ability to accept change and responsibly affect the future (Ibrahim & Syed, 2022). The value of STEM in schools for successful instruction requires several knowledge. Because STEM provides teachers and students with excellent educational opportunities, it is vital to benefit both sides (Imaad et al., 2016). With teachers' knowledge and skills, teachers can quickly plan and prepare classes, create processes and materials for the content of lessons, and design it simple for students to share learning ideas and resources with one another (Misseyanni et al., 2020). Unfortunately, most STEM training is typical for interaction and better instruction methods. With a concentration on students, integrated STEM learning can improve subject matter, promote problem-solving techniques, and improve critical thinking qualities (Cartagena et al., 2017).

Background

Throughout a seminar, the Pakistani Ministry of Planning, Development & Reform observed that public school instructors couldn't show off their full potential and science-based competencies because they could not get paid more. (Abbas & Foreman-Peck, 2008). In order to push an effective and fruitful workforce in Pakistan, it is essential to have an exhaustive knowledge of current teaching theories and methods in STEM middle education. Many Asian regions, namely West, East, and South Asia, are implementing and advancing STEM education (Chen & Chang, 2018; Wahono et al., 2020). Teaching proficiency, a weak STEM curriculum, untrained teachers, and a shortage of competitive employment are some problems in Pakistan that have been brought to light (Moghal et al., 2020).

STEM teachers in Pakistan have several difficulties: the STEM curriculum has weak standards, and the student activities need to be improved to meet the complete objectives of this type of education. Private education focuses more on STEM education than those public schools. As a result, there need to be more labs, pieces of technology, or other resources available to teach STEM (Qadir & Suleman, 2018). STEM education in Pakistan is confronted with several difficulties, such as the lack of STEM teacher training, a weak STEM curriculum, and insufficient student engagement in STEM activities.

LITERATURE REVIEW

STEM education is a multidisciplinary teaching approach that covers all educational levels and includes instruction and evaluation (Gomez & Albrecht, 2013; Gonzalez & Kuenzi, 2012; Kiazai et al., 2020). STEM education is a combined strategy that continuously mixes science, innovation, design, and math academic areas (Bryan et al., 2015; Cinar et al., 2016; Diana & Sukma, 2021; Kiazai et al., 2020). STEM instruction method focuses on science, technology, engineering, and math and is also about learning, exploring, problem-solving, inquiry, and experience in their education (Soros et al., 2018; Ibrahim & Syed, 2022; Soros et al., 2018).

According to its benefits, learners in traditional schooling are also given opportunities. STEM education and training integrating science, education, population, national security, and transfer strategy greatly interest government administrators (Kiazai et al., 2020; Tan et al., 2023). Researchers in science highlight the importance of connected, collaborative STEM learning that supports students in learning about real life through inquiry, implementation, and problem-solving techniques (Asghar et al., 2012; Kelley et al., 2023). STEM education is widely seen as a crucial element and is being used in numerous nations. However, because STEM education differs from other traditional subject areas, emphasizing different teaching strategies, its implementation has presented several challenges for educators, school leaders, and other stakeholders (Idris et al., 2023; Qureshi & Qureshi, 2021).

The analysis identified six key areas of difficulty that teachers had to deal with; teaching methods, content and curriculum difficulties, problems with different teaching techniques, student interest, assessment and evaluation issues, and teacher support. STEM advancements will require a vast workforce that is highly skilled and challenged-engaged individuals who can persevere and handle failure constructively (Estonanto, 2017; Firdaus & Rahayu, 2019). The knowledge, skills, and opinions developed at the border of many STEM subject areas are included in STEM training (Corlu et al., 2014; Kiazai et al., 2020). Many developing countries are inexperienced with combined STEM education since it requires essential teacher training and competence and the availability of necessary teaching and learning resources. Moreover, all these subjects are taught as signal subjects rather than implementing STEM education in Pakistan (Aslam et al., 2022; Awan et al., 2017).

Teachers frequently believe that their teaching philosophies must change to implement STEM education successfully. This thinking makes some educators feel unprepared to implement STEM, becoming a barrier (Al Salami et al., 2017). It also highlighted how teachers see the integration of STEM subjects and how to incorporate them into STEM-related

activities in the classroom (Ibrahim & Syed, 2022). The implementation of STEM instruction needs to be improved by school systems as well. The constraints of class timings negatively impacted STEM's transdisciplinary approach to teaching, and teachers of different subject areas cannot carry out multidisciplinary work and appropriately co-plan their lessons (Kiazai et al., 2020). Teachers' understanding is one factor that affects their ability, affecting how STEM is applied in the classroom. In addition, educators must have a sufficient understanding to support students in developing skills that meet the demands of the twenty-first century (Khalil & Osman, 2017; Rifandi & Rahmi, 2019).

The problem is the lack of students' motivation to engage in STEM studies, and teachers have little understanding of STEM subjects (Shafiq & Parveen, 2023; Susilo & Sudrajat, 2020). For the improvement and effectiveness of STEM learning and teaching methods, knowing the additional challenges teachers experience while applying STEM is essential. These challenges have been made clear by identifying these barriers to teaching and learning regarding STEM (Diana, 2021; Kennedy & Odell, 2014).

According to (Thi To Khuyen et al., 2020), Teachers must be skilled in these subjects and have the teaching capabilities to convey them as demanded. According to preservice instructors, STEM skills, educational information, cross-curricular, integrated knowledge, real-life connections, and interest are all necessary for STEM education. They also said that educators must be creative, productive, and attentive to new concepts, informed about the twenty-first century's scientific fields, and offer learners various abilities. (Kommers, 2019), stated that question-answer learning methods and teacher-centered learning that convey information through their knowledge in STEM help students to learn effectively, which also helps them in their communication, collaboration, and problem-solving skills in their educational process. As said by (Aslam et al., 2022), the concept of STEM education is a strategy, and its implementation needs different skills in different areas, which is a challenge for teachers.

One of the most significant challenges to teachers implementing STEM integration is the need for suitable assessment tools, time preparation, and subject-matter knowledge in the fields of STEM (Nadelson et al., 2017). STEM programs identify challenges that must be integrated and used effectively in solving problems in science, technology, engineering, and mathematics (Ibrahim & Syed, 2022). It is challenging to make interconnected STEM connections; teachers must plan classes that help students understand how STEM concepts are applied to actual-life problems. Teachers must address the material and the approach to establishing these relationships (Greca Dufranc et al., 2020).

For most educational systems worldwide, STEM learning is a logical approach. When teachers have a choice of outstanding STEM education programs that support them in successfully implementing the four STEM disciplines into important methods of instruction, they have a better chance to teach knowledge and skills to learners that can impact their learning (Özcan & Koca, 2019). According to different research on STEM education, most teachers believe that STEM instruction is essential and will improve students' motivation and learning (Moghal et al., 2020; Park et al., 2016). Moreover, a teacher may not be willing to try new technology and methods in the classroom due to a lack of experience or understanding (Ercan et al., 2016; Moghal et al., 2020; Uzun & Sen, 2023). Teachers must be knowledgeable about the different technologies, tools, and resources and establish strong connections between their curriculum and teaching methods to make their STEM teaching successful and meet the needs of the students (Wood et al., 2018; Parveen et al., 2022). For STEM implementation to succeed, they also require multiple tools and educational resources that offer beneficial STEM experiences (Moghal et al., 2020; Phuc et al., 2021).

STEM programs highlight challenges that must be integrated to successfully address science, technology, engineering, and math-related problems. Because so many issues may be resolved, students are exposed to various scientific and technological tasks during the STEM period. As a result, education is both relevant and an approach for learners and society to address today's problems. This is an excellent way to prepare for a future generation of STEM instructors so our society can remain competitive (Fernández-Limón et al., 2020). Yet, there is limited knowledge regarding the delivery of STEM education in Karachi, Pakistan. This study was created to fill this void. The following research question guides the current investigation: What obstacles does STEM education face in Primary schools in Karachi, Pakistan?

RESEARCH METHODOLOGY

The current study focuses on qualitative research design to determine what difficulties teachers in Karachi, Pakistan, face when implementing STEM education. As the study of phenomena' nature, qualitative research is particularly suitable for addressing why certain phenomena are observed (or not), evaluating intricate multi-component treatments, and concentrating on enhancing interventions (Aslam et al., 2023; Zainil et al., 2023). Open and semi-structured interviews with elementary school students were used to collect the data.

Participants

Ten primary school teachers, eight females and five males, with expertise in STEM subjects and a strong understanding of STEM education, were selected as a target population in this research context (Table 1). The participants were chosen using the purposive sampling (Le et al., 2021). Accordingly, on average, among ten primary

teachers, 02 teachers taught one similar subject: Science, Environmental Studies, Mathematics, and ICT (Computer and Information Technology). They all possessed considerable teaching expertise, ranging from 7- 20 years of experience in primary school education (Mean= 11.8). All of them had experience in STEM teaching. In their schools, some teachers also held administrative responsibilities, and regarding their professional development, these educators took part in frequent programs run by their schools.

Data Collection and Analysis

Data collection began with written consent from participating teachers. The teachers were informed that the interview was conducted for research reasons only, and their confidentiality was respected. Teachers were urged to openly discuss their experiences and difficulties in teaching STEM. Semi-structured interviews were used in the data collection process. The interview questions were designed by comprehensively examining the literature about teachers' perspectives, apprehensions, and challenges when teaching STEM subjects (Margot & Kettler, 2019).

The interview questions involved three teachers (not included in primary studies) from three distinct schools. Teachers were invited to provide feedback on the questions' content and clarity. We could anticipate the length of the primary interviews and change the wording of a few questions owing to the piloting interviews. Because the interviews were semi-structured, the questions were designed to be both narrow enough to direct participants' attention to the research's main topic and broad enough to allow them to delve deeply into their experiences teaching STEM subjects. The final interview, including 05 interview questions, was conducted face-to-face with each participant from August 2023 to October 2023. Teachers were urged to share as much of their knowledge, comprehension, opinions, and experiences as possible and the difficulties they encountered while incorporating STEM into their regular lesson plans. Each interview lasted between 35 and 45 min. Every interview was audio recorded so the data could be transcribed and analyzed later. After reading the complete transcript, the data was searched for significant themes and trends. The movements were examined through iterative data reading, coding, and theme development. The pieces were determined, updated, clarified, and given examples.

Table 1: A Brief Summary of Participants' Background Information

Teacher	Gender	Subject Background	Teaching Experience (years)
T1	F	Science and Environmental Studies	20
T2	F	Science and Environmental Studies	17
T3	F	Science and Mathematics	15
T4	F	Science and Mathematics	10
T5	M	Mathematics	15
T6	M	Environmental Studies	10
T7	F	ICT	07
T8	F	ICT	10
T9	F	ICT	07
T10	F	Environmental Studies	07

Range 7-20, Mean= 11.8 Field Survey, 2023

RESULTS

Insufficient teacher training for integrating STEM

Every teacher believed that their understanding of STEM was inadequate. They claimed that although they were prepared to teach a particular subject, STEM integration necessitated an interdisciplinary knowledge of math, science, technology, and engineering. They said their lack of multidisciplinary expertise prevented them from creating and implementing engaging STEM lessons. Additionally, even though the teachers had taught STEM subjects before, they still felt unprepared and that STEM was new. T1 said, "The most needed aspect in STEM education is the knowledge of integration of subjects. It is necessary to train teachers to take advantage of the interconnected lessons in different subjects and integrate them to create STEM-related activities. Moreover, I have noticed that even though the teachers have planned STEM activities, they do not know how to assess and evaluate the learning from those activities".

According to T2, the most significant obstacle he faced was a need for an in-depth understanding of STEM integration in terms of STEM knowledge, STEM lesson design, and STEM lesson protocol. T3 stated that traditional teaching methods were inappropriate for teaching STEM, and their ingrained traditional teaching habits prevented them from experimenting with new teaching techniques or methods for teaching STEM. So, to improve his teaching outcomes, T3 requested additional STEM teaching methods. T4 said, "My first issue is that I do not know much about STEM education. I was apprehensive about adapting my teaching strategies to fit STEM. To develop my capacity to teach STEM, I reasoned that I should take on the obstacles and take the initiative to learn about STEM and share my knowledge and expertise with colleagues". The teachers admitted that their teaching methods were conventional and centered on imparting knowledge from their lecturers to the students rather than assisting the students in applying or discovering the understanding.

Limited resources and an uncompromising school system

Sufficient resources are necessary for a successful STEM integration, including time and place for teamwork, planning time, and technology. Teachers from several disciplines must collaborate when executing STEM lessons. However, according to the teachers in this survey, they needed more time or room for teamwork. T4 mentioned that collaborating with other educators to prepare STEM lessons took much effort. Due to their extensive teaching schedules, the teachers were very busy. Their already hectic schedules were further burdened by having to collaborate with other teachers to prepare for STEM classes. T3 said, "One of the main obstacles is time constraints. Not everyone can evaluate my issues and queries quickly. It is not feasible for me and my colleagues to conduct a typical lesson [a lesson in a specific subject domain] for only 45 minutes using one STEM topic". T5 stated that there were no required STEM classes and that the teaching assignments were finalized at the start of the term.

According to T7, there ought to be a formal STEM curriculum that is appropriately established at the beginning of every academic year. Regarding the curriculum and school organization, the teachers believed there were obstacles to integrating STEM education. Teachers felt there was no unity because STEM teaching activities were not arranged in a way that made sense for the classroom organization. Large class sizes and various level classes were present, but there needed to be more instructional resources, such as STEM teaching-related technology. T2 said, "She took the initiative, along with her colleagues, to arrange educational supplies from various vendors, including parents of the pupils. Her school did not provide her with sufficient assistance".

The focus groups placed much attention on outside variables, especially the scarcity of resources. We also observe that classroom facilities and technology are necessary to expect the instructor to teach STEM topics. Teachers would undoubtedly alter their methods if there were adequate facilities.

Professional development

Lack of professional training is also a critical factor. The teachers were worried about lacking a curriculum framework, resources, and suitable models for STEM education. The teaching resources and equipment they were given were exclusively for the subject domains they covered and were not intended for interdisciplinary teaching. This was because the existing curriculum was created for each subject part to equip knowledge of fundamental fields. They frequently struggled to find STEM-related topics and needed an inclination to include STEM in the curriculum.

According to T8, the available STEM teaching resources are theory-based, and more appropriate and compatible practical guidelines, actual examples, and instructional equipment are needed. According to T5, there is no single STEM curriculum, and schools and teachers are implementing STEM in their unique methods, depending on their strengths and limitations, so a professional instructor whose guidance will help us is required. Regarding assessment, every teacher stated that the lack of direction from school administrators made it difficult for them to evaluate students' success in STEM education.

The teachers thought assessing students' success in STEM learning activities was different from the proper use of their traditional paper-based test-based techniques for gauging their knowledge. They realized that evaluations should be given to the items produced by students and the involvement process in STEM activities. However, teachers were worried about their pupils' sense of fairness because their customary assessments were done individually, whereas students worked in groups. T4 said, "Professional Development should offer regular training and workshops that equip teachers with the necessary skills to effectively teach STEM concepts, use relevant tools, and manage hands-on activities."

Teachers need professional development to teach STEM subjects, given the absence of knowledge and even teacher education preparation in such cutting-edge methodology. Universities or training facilities may be used for this. We must emphasize problem-solving and discovery learning, which are essential for STEM educators. How will we teach STEM lessons without even trusting this new method? Teachers ought to be well-informed when they enter the classroom. He is unshakeable and unwavering in his self-confidence. We can only imagine this occurring if he obtains instruction that boosts his effectiveness and self-confidence.

Time Constraint

The most pressing problem that STEM (Science, Technology, Engineering, and Mathematics) educators face is time constraints, which poses a critical challenge of needing more time to cover all the content they need within the limited class hours. Providing STEM education can indeed be extremely difficult when there are time restrictions. Teachers are reluctant to prepare STEM activities when they have limited slots or a short unit, usually 40 minutes. T1 said, "Teachers are expected to cover extensive, standardized curricula currently in place in many education systems. Because of time constraints, it can be challenging to incorporate extra courses or activities while introducing STEM education.

T3 stated, "I don't have sufficient time to produce suitable teaching resources for STEM education." Concise lessons that touch on complex STEM ideas deprive students of experiential and thoughtful learning opportunities, limiting their knowledge base. T7 stated, "There is a weekly limit on how much time students can spend with their teachers

in my school. It could be challenging to fit in-depth STEM projects or activities that need prolonged involvement into this short time". T5 stated that maths is a topic with greater academic significance than science and technology. I find creating and teaching STEM lessons challenging, as do other maths teachers. Additionally, as math is a fundamental subject, we must devote more time to it than other teachers in the field. T10 stated that I needed more time to complete the required syllabus. Then in addition, the contradiction between teachers' commitment to fulfilling the curriculum's educational aspects and the need for students to understand the material and be involved is also crucial in time management in STEM education. Also, providing personalized assistance may be severely reduced by a time crunch, negatively affecting the student's learning process.

Curriculum Standards in Classrooms

The teachers were worried about lacking a curriculum framework, resources, and suitable models for STEM education. The teaching resources and equipment they were given were exclusively for the subject domains they covered and were not intended for interdisciplinary teaching. This was because the current curriculum was created for each topic domain to provide knowledge of fundamental subjects. T3 stated that her most significant issue was developing an intriguing topic idea that fit the curriculum. She advocated for a national curricular framework that instructors may modify to suit the needs of their particular teaching environments. Ensuring correlation while encouraging innovation and creativity in teaching and learning represents a balancing act that should be treated with special care. T4 stated that the STEM curriculum materials available were theoretical. Teaching tools, tangible examples, and practical guidelines needed to be revised and compatible. The available resources were deemed incompatible with the dynamic needs of STEM education. T6 claimed no cohesive STEM integration in the current curriculum, which concentrated on individual disciplines. In her opinion, there ought to be a distinct STEM course that offers the same resources, guidelines, credits, and teacher preparation as other courses. Furthermore, according to her, no single STEM curriculum existed, and schools and teachers approached the subject differently, depending on their strengths and shortcomings.

T9 stated that students' academic backgrounds are challenging for me while designing class curricula. She said that students have different approaches to learning and backgrounds and differing degrees of existing knowledge. It can be challenging for teachers to create curriculum standards that support equity and inclusivity while meeting the requirements of a varied class of students.

STEM curricula guidelines present teachers with a dilemma due to their complex nature and the standards becoming updated frequently. It takes attention to detail and thorough preparation to implement the standards and use resources. Knowing how to strengthen standards while provoking students' talent and minds is a task for creative strategies. Teachers are expected to outline various forms of learning within the required standards in a limited time frame. The up-to-date familiarity with changing standards and their application while teaching STEM is critical for staff professional development so educators can improve their science teaching skills to suit modern students' learning needs best.

DISCUSSION

The present study explored primary school teachers' challenges in integrating STEM education in Karachi, Pakistan. Consistent with earlier research conducted in different educational settings, the teachers of our study experienced a variety of challenges in managing, preparing, and teaching STEM modules (Le et al., 2021; Margot & Kettler, 2019). The significant difficulties discussed in this study were (i) Insufficient teacher training for integrating STEM, (ii) Limited resources and an uncompromising school system, (iii) Professional Development required, (iv) Time Constraints, and (v) Curriculum Standards in classrooms. These essential elements were documented in studies conducted in different countries (Shafiq & Parveen, 2023; Aslam et al., 2022; Phuc et al., 2021). However, 02 subthemes, including time constrain and curriculum standards in the classroom, found research gaps and are somewhat unique in our study. These difficulties are due to the complexity and existing sociocultural background in learning and teaching (Nadelson & Seifert, 2017; Phuc et al., 2021).

One of the primary obstacles identified is the need for more training and expertise among teachers in STEM integration, which is commonly discussed in the literature (Ryu et al., 2019; Aslam et al., 2023). Many educators feel they need to be equipped to create engaging STEM lessons due to their limited interdisciplinary knowledge and lack of familiarity with STEM teaching methods. The lack of STEM components in the undergraduate programs of all the teachers, coupled with their extensive teaching experience of more than seven years, underscores the necessity for comprehensive in-service teacher training in STEM education. This finding highlights the importance of prioritizing regular professional development programs to support STEM teachers in meeting the evolving educational needs of students. Specifically, teachers must have the knowledge and skills to ensure that instruction, particularly in STEM education, transcends mere rote memorization of concepts. This recommendation, emphasizing the application of learning to real-world problems, could be relevant and beneficial in Pakistan and various similar contexts worldwide.

Limited resources and the inflexible structure of the school system also present formidable challenges to STEM integration. Teachers expressed concerns about the need for more time, space, and collaborative opportunities necessary for effective teamwork and lesson planning. Additionally, adequate teaching resources and equipment help educators' implementation of hands-on, experiential learning activities in STEM subjects, especially in rural areas and developing countries. Additionally, this result has been frequently noted in earlier research (Tan et al., 2023; Parveen et al., 2022; Shafiq & Parveen, 2023). All ten teachers in the current study expressed dissatisfaction about their lack of practical resources for successful STEM instruction. This may be because Pakistan's Karachi employed these educators in rural and suburban schools. Teaching resources are generally lacking in these schools' STEM subjects. The solution to this problem may require some time and work. Developing teachers' coping mechanisms to implement STEM integration within the constraints of the current teaching and learning contexts may need to be the main emphasis of in-service teacher training and professional development programs. Additionally, it can guarantee long-term instructional strategies. The present study's most noteworthy finding relates to the instructors' opinions about STEM education. Teachers' motivation, involvement, and initiative in implementing successful STEM lessons were mainly influenced by the conflict between their views about the importance of STEM education in helping students develop their problem-solving skills and their ideas about the immediate objectives of education in their local contexts. The educators wanted to focus on imparting STEM knowledge to their kids since they knew it would benefit their future.

Moreover, time constraints pose a critical challenge to providing comprehensive STEM education within the confines of the traditional school schedule. Teachers need help to cover extensive curricula while incorporating STEM activities and projects that require substantial time commitment. This limitation inhibits students' opportunities for experiential learning and deep engagement with STEM concepts. The need for clear curriculum standards further complicates integrating STEM education into classrooms. Teachers grapple with aligning their lesson plans with evolving standards while fostering creativity and innovation in teaching and learning. The absence of cohesive STEM integration within existing curricula underscores the need for a unified framework that provides teacher guidance and resources. It is important to note that teacher interviews revealed a favorable attitude toward how STEM integration boosts students' desire to study science and seek STEM-related jobs in the future.

CONCLUSION

This study fills a gap in the research field of challenges to STEM integration faced by primary school teachers in Karachi, Pakistan. The research findings revealed numerous challenges hindering teachers' efforts to incorporate STEM modules into their curriculum. These challenges encompassed teachers' restricted proficiency and inventive approaches in delivering STEM education, as well as practical constraints such as insufficient time, limited space, and a scarcity of materials and technical resources. In order to help teachers feel more confident and more equipped to teach STEM, it is advised that in-service teacher professional development programs should focus more on providing teachers with up-to-date STEM knowledge and teaching strategies. Designers and facilitators of teacher professional learning and development must equip educators with the know-how to handle setbacks and modify their teaching environments to better align STEM education for their institutions and students. Investing in teacher training programs, providing adequate resources and support, and revising curriculum standards to reflect the interdisciplinary nature of STEM education are essential steps toward fostering effective STEM integration in schools.

By addressing these challenges, educators can better prepare students for success in an increasingly complex and technology-driven world. The research findings imply that administrators should consider their STEM education and students' STEM performance while evaluating teachers. It should be mentioned that although this qualitative study was limited to teachers in a single Pakistani metropolis, the conclusions and suggestions made can likely be implemented in other Asian educational environments as well as other regions of Pakistan where exam culture has a significant impact on teaching and learning.

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