Bridging the Gap: How Teaching Strategies and Institutional Support Drive Student Motivation in STEM

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Abstract

This quantitative correlation survey was designed to explore the relationship between teachers' effective STEM teaching strategies and institutional support for students' engagement and motivation in public secondary schools of Quetta, a city of Balochistan. By employing a simple random sampling method, 300 science subject teachers were selected for data collection. A self-structured questionnaire based on three sections, including demographic, institutional support (9 items), and teaching strategies (18 items), was developed, which was found to have strong reliability on Cronbach's alpha (.987). The data was analyzed quantitatively by using simple linear regression and one-way ANOVA. The result reveals that there is a significant positive relationship found between teaching strategies and institutional support for students' engagement and motivation ($R^2 = 0.414$, $p < .001$). Further, gender disparity was significant for institutional support ($p = .004$) only. The study suggests that strong teaching strategies not only enhance institutional support but can also improve STEM education through collaboration efforts of stakeholders who can provide resources, investment, and opportunities for teacher training.

Keywords: STEM, Education, Teaching Strategies, Institutional Support, Students' engagement and motivation

Introduction

Educational development is evolving to become more diverse, personalized, and globalized, aligning with the rapid pace of the technologically driven world (Rehman et al., 2023; Xing, 2023). The conventional education system primarily aims to deliver specific subject-oriented information; however, the modern system will prioritize the development of students' overall skills and abilities to compete and sustain in this global era. Possessing these extensive abilities will emerge as a distinct advantage for individuals in tomorrow's civilization. As globalization progresses, education will increasingly focus on developing individuals with global perspectives and strong cross-cultural communication skills. However, in this era, there has been an increased focus on addressing social development requirements and fostering individuals with a heightened sense of social responsibility and environmental consciousness. Education will emerge as a significant catalyst in nurturing sustainable social development, facilitating the cultivation of responsible and emotionally resilient individuals within society. In the forthcoming advancement of education, it is imperative to consistently engage in innovation and exploration, effectively respond to the demands of societal transformation, and address the obstacles and complexities encountered within the realm of education. Education has a crucial role in fostering societal progress. To foster exceptional talents for the future society and contribute to its prosperity, stability, and equitable growth, we must embrace scientific education principles, prioritize education quality, acknowledge individual differences among students, and actively advocate for digital and global education (Sajjad, 2018). Individuals' collective efforts and contributions are critical for the optimal advancement of education.

Thus, in this regard, STEM (Science, Technology, Engineering, and Mathematics) education has numerous significant benefits at the individual level (innovation, entrepreneurship, increased prosperity, and economic growth), societal level (developments in medical research, healthcare technology, and disease prevention to improve health and well-being), and global levels (pressing global challenges, such as poverty, inequality, and climate change, helping individuals and nations compete in the global economy), as illustrated in literature (Eroğlu & Bektaş, 2022; Hynes et al., 2023; Sajjad et al., 2013; Skrentny & Lewis, 2022). Therefore, by stressing STEM education in school settings for students' development, individuals, communities, and nations can secure numerous benefits, like driving innovation, economic growth, and societal progress.

Objectives

1. To explore the relationship between effective strategies used by teachers to teach STEM education and institutional support for students' engagement and motivation for STEM education.
2. To determine the gender disparity in the effective strategies used by teachers to teach STEM education and institutional support for students' engagement and motivation for STEM education.

Review of Related Literature

Literature highlights that it is essential to motivate students through their active involvement in STEM education to accomplish the desirable goals of STEM (Tohani & Aulia, 2022; Van den Hurk et al., 2019). A study highlighted that in high-quality STEM education, students require systematic programs in rigorous curriculum, assessment, and teaching strategies (Kennedy et al., 2021; Sajjad, 2010). According to scholars, there is a need to redesign the school curriculum to develop skills related to STEM education, specifically when integrating engineering and technology into the mathematics and science curriculum (Katsioloudis & Moye, 2015; Khan et al., 2024). Furthermore, some measures have been taken by various countries to effectively instruct students in STEM education and support their education stakeholders to inspire, motivate, and encourage their students in STEM subjects (Liu et al., 2022; Mendick et al., 2017). Meanwhile, developing countries also took initiatives to include STEM education and related instructional skills through training. So, their students can prepare themselves to face challenges of global warming and environmental safety, which ensures prosperity in changing world conditions (Hasanah, 2020; Razi & Zhou, 2022; Shah et al., 2023; Zaman et al., 2023).

To develop effective implementation of STEM education, teachers should be trained in effective teaching strategies to teach STEM, such as inquiry-based learning, project-based tasks, and hands-on experiments. These effective teaching strategies have been shown to significantly enhance student interest, engagement, and motivation in STEM subjects (Freeman et al., 2019). Studies highlight that in STEM education, students' engagement and motivation increase when teachers apply real-world applications, problem-solving approaches, and hands-on experiences that help students see the relevance of STEM to their careers and lives (English, 2016). Furthermore, institutional support directly contributes to teachers' ability to deliver engaging STEM instruction, including supportive leadership, access to resources, STEM-specific training for teachers, and collaborative planning time (Evans et al., 2020; Gerde et al., 2023). Here, a positive school climate supported by the school fosters innovation, collaboration, and teacher autonomy that ultimately encourage the adoption of innovative and student-centered STEM teaching methods (Hali et al., 2021).

However, professional development and institutional backing empower teachers to sustain and implement effective instructional practices to improve students' learning outcomes in STEM education, highlighted by Ibrahim and Syed (2022). Thus, the combination of teaching strategies employed by teachers and institutional support has a compounding effect on students' engagement and motivation, particularly in under-resourced schools where resources and supports are limited (Jayarajah et al., 2014; Manik et al., 2022).

The study uncovers the integration of dual factors, as few studies have examined the combined effect of teaching strategies and institutional support on students' engagement and motivation in STEM; most focus on one or the other. Furthermore, the literature lacks context-specific evidence, as limited research exploring these dynamics within primary and secondary school settings, especially in developing countries.

In addition to that, no literature has been conducted on the STEM education related to institutional support for students' engagement and motivation, and teaching strategies used by teachers in teaching STEM education, especially in Quetta, a city in Pakistan. Thus, the current study was designed to explore how teaching strategies and institutional support drive students' engagement and motivation in STEM education.

Research Methodology

This quantitative correlational study explored the perception of science subject teachers in order to explore the relationship between effective strategies used by teachers to teach STEM education and institutional support for students' engagement and motivation for STEM education in secondary schools of Quetta, a city of Balochistan, Pakistan. The research population comprises all the science subject teachers of public sector secondary schools in District Quetta, Balochistan. There were 148 public secondary schools in Quetta (76 boys' schools and 72 girls' schools). Whereas the total population of teachers was 643, among them there were 288 female teachers and 355 male teachers. The sample size of schools and teachers was drawn through the Krejcie and Morgan Table, see Table 1. Thus, 300 science subject teachers were selected through a simple random sampling method.

Table 1
Sample Size Determination Using Krejcie and Morgan Table

			N		Sample Size as per Krejcie & Morgan Table	
Schools			148		119	
Boys school			76		63	
Girls' schools			72		59	
Secondary School Teachers			643		242	
Female			288			
Male			355			
		F		%	*M*	*SD*
Gender					1.53	.500
	Female	140		46.7%		
	Male	160		53.3%		

The researcher self-structured the questionnaire to conduct a survey, which consisted of 27 closed-ended items, whose reliability was found strong on Cronbach's Alpha (.987). the tool was divided into three sections. Demographic, institutional support for students' engagement and motivation (9 items, reliability .987), and strategies used by teachers in STEM education (18 items, reliability .986). furthermore, content and inter-item reliability were also observed to be consistent. Institutional support was measured through the statements about how schools support and motivate students' engagement in STEM education through professional development, community involvement, peer learning, mentorship, and resource access, which emphasize institutional efforts to enhance student-centered STEM opportunities. The tool was developed on a 5-point Likert scale from strongly agreed to strongly disagreed. The data were collected by the researcher on the spot with ethical guidelines provided by the research ethics committee.

Findings

Research Question 1

Is there a relationship between effective strategies used by teachers to teach STEM education and institutional support for students' engagement and motivation for STEM education?

> **Research Hypothesis (H_1):** There is a significant positive relationship between effective strategies used by teachers to teach STEM education and institutional support for students' engagement and motivation for STEM education.
>
> **Null Hypothesis (H_0):** There is no significant positive relationship between effective strategies used by teachers to teach STEM education and institutional support for students' engagement and motivation for STEM education.

Table 2 reports a simple linear regression to predict institutional support for students' engagement and motivation based on teachers' use of effective strategies to teach STEM education in secondary schools. The regression model indicates that the teachers' use of effective strategies significantly predicts institutional support for students' engagement and motivation as $F (1, 298) = 210.80$, *p*-value = .000. The coefficient of determination ($R^2 = .414$) indicates that there is approximately 41.4% of the variance existing in institutional support for students' engagement and motivation is explained by the teachers' use of effective strategies to teach STEM education. Meanwhile, the standardized coefficient suggests a moderate to strong positive relationship (.644) between strategies used by teachers and institutional support for students' engagement and motivation. However, the unstandardized coefficient indicates that for each unit increase in teachers' use of effective strategies, institutional supports are expected to increase by 1.423 units. Furthermore, the t-test for the slope was significant, $t(298) = 14.52$, $p < .001$, which also confirms that teachers' use of effective strategies to teach STEM education is a significant predictor of institutional support for students' engagement and motivation.

Table 2

Regression Analysis between the Strategies Used by Teachers and Institutional Support for Students' Engagement and Motivation

Model Summary [a]	R	R^2	Adjusted R^2	Std. Error of Estimate	Change Statistics: R^2 Change	F Change	df1	df2	Sig. F Change
1	.644 [b]	.414	.412	.721	.414	210.795	1	298	.000

Coefficients [a]		Unstandardized Coefficients B	Std. Error	Standardized Coefficient Beta	t	Sig.
1	(Constant)	.049	.252		.196	.845
	Strategies	1.423	.098	.644	14.519	.000

a. Dependent Variable: Institutional Support for Students' Engagement and Motivation
b. Predictors: (Constant), Strategies

Research Question 2

Is there a significant difference in gender disparity in the effective strategies used by teachers to teach STEM education and institutional support for students' engagement and motivation for STEM education?

Research Hypothesis (H_2): There is a significant gender disparity in the effective strategies used by teachers to teach STEM education and institutional support for students' engagement and motivation for STEM education.

Research Hypothesis (H_0): No significant difference exists in the gender disparity in the effective strategies used by teachers to teach STEM education and institutional support for students' engagement and motivation for STEM education.

Table 3 determines the gender disparity in the variables: institutional support for students' engagement and motivation, and teaching strategies used by teachers to implement STEM education. Among the variables, institutional support for students' engagement and motivation (F = 8.275) is statistically significant at the .05 level (p = .004). In contrast, the variable strategies used by teachers to teach STEM education (F = .359) are not statistically significant, as *the p-value* is greater than .05 (p = .550). Thus, gender significantly affects perceptions of the institutional support only.

Table 3
One-Way Analysis of Variance for Gender Disparity

		Sum of Squares	df	Mean Square	F	Sig.
Institutional Support	Between Groups	9.519	1	9.519	8.275	.004
	Within Groups	342.763	298	1.150		
	Total	352.282	299			
Strategies	Between Groups	.065	1	.065	.359	.550
	Within Groups	54.105	298	.182		
	Total	54.170	299			

Conclusion and Discussion

Discussion

Results reveal that the majority of the participants expressed concern about the lack of school support to enhance students' engagement and motivation for STEM education; however, a considerable number of participants agreed on the support provided by the school to improve students' engagement and motivation for STEM education. Moreover, the majority of the participants revealed that there is a lack of STEM resource centers to provide accessibility to students. By a considerable number of participants, it was also highlighted that there is a lack of promotion of STEM learning outside the classroom through community engagement. Studies showed that business collaborations and community participation have a key role in improving STEM learning experiences for students (Nash, 2017; Siddiqui et al., 2019; Shah & Sajjad, 2024), and the community interaction outside the classroom is seen as beneficial to STEM learning (Debora & Pramono, 2021). Thus, the study reveals that the collaborations among various stakeholders provide students with excellent opportunities for mentoring, internships, and exposure to STEM jobs.

For STEM education, several factors can enhance students' engagement and motivation, as students' encouragement and motivation influence STEM learning. These include: provision of more professional development opportunities by schools to help students focus on STEM; students' collaboration with external STEM organizations facilitated by schools; community engagement outside the classroom to promote STEM learning; STEM learning opportunities for students through the STEM curriculum in secondary schools; mentorship programs provided by schools to help students take interest in STEM fields; implementation of peer-to-peer STEM initiatives by schools; developing a STEM resource center within schools for student access; schools offering incentives to teachers to develop innovative mindsets among students; and, creating awareness among parents regarding the importance of student participation and performance in STEM education. Other studies also emphasized the need for an organized curriculum (Reynders et al., 2020; Saleem & Sajjad, 2025), the need for curriculum reform that involves adding STEM, iSTEM, and STEAM domains to national/provincial curricula, as highlighted by Razi and Zhou (2022, p 1), and the integration of robotics technology, fostering creativity and encouraging active involvement in their educational journey (Amjad et al., 2024; Lavigne et al., 2007) to generate excitement among students for STEM fields. Similarly, Mustafa et al. (2022) also found a significant positive effect of the classroom environment, teachers' feedback, and motivation on students' academic achievement.

In the secondary schools of Quetta, teachers used different strategies to enhance STEM education. These strategies were using physical models, cooperative learning, computer simulations/apps, inquiry-based instruction, project-based learning, the concepts of similarities and differences, graphic organizers, videos or images, direct instruction, problem-based learning, small group discourse, whole group discourse, differentiation through hands-on learning, and building physical models. Furthermore, it included setting objectives, providing feedback to students, reinforcing efforts, providing recognition to students, encouraging summarizing and note-taking techniques, fostering creativity through open-ended questions, inviting guest speakers or experts in STEM field, giving homework to practice learned topics, writing a scientific argument, using real-world application, and teaching digital literacy to students.

The majority of participants always, often, and sometimes utilize these strategies to enhance STEM education in their classrooms. Among the mentioned strategies, the majority used the strategy of identifying similarities and differences. In contrast, the least used strategy was 'inquiry-based instruction'. Previous studies emphasized that STEM education should give importance to applying scientific and mathematical principles to real-world issues and encourage hands-on, inquiry-based, and problem-solving learning in an environment (Kelley et al., 2020). However, supporting experimentation and problem-solving in the classroom encouraged students to design solutions to real-world problems, as highlighted by Nilimaa (2023). Smart classrooms, which are an upgrade of digital classrooms (Boss & Krauss, 2022), can integrate various advanced technologies (Chiu et al., 2021; Rehman & Sajjad, 2025) and are appropriate for interactive STEM lessons and tasks, for applying enhanced teaching, motivating students, and developing their abilities (Coté, 2024). Engaging students in collaborative, project-based learning experiences fosters a sense of curiosity, problem-solving skills, and a positive disposition towards STEM disciplines (Moore et al., 2020). Active learning is essential for STEM education, which requires students to actively participate in the learning-by-doing process and think critically about what they are doing (Yaki, 2020). The engineering design process used in STEM and the problem-solving steps are similar; therefore, STEM supports and develops problem-solving skills, as also emphasized by Yıldız-Feyzioğlu and Demirci (2021).

Empirical evidence from Pakistan suggests mentoring is effective for science teaching (Abbas et al., 2023; Hali et al., 2021; Khan et al., 2021; Sajjad et al., 2019) and to strengthen science and technology, there is a need to provide sufficient resources, techniques, and equipment at the grassroots level, i.e., at the educational institutes' settings (Mustafa et al., 2022), and collaboration, mentoring, and exposure to innovative teaching practices is required to enhance STEM educators' effectiveness (Imaad et al., 2016).

Conclusion

The study concludes that there is a significant positive relationship between effective teaching strategies used by teachers to teach STEM education and institutional support for students' engagement and motivation in STEM education. Results of the study reveal that strategies used by teachers in STEM teaching account for 41.4% of the variance in institutional support for students' engagement and motivation, indicating a moderate to strong effect. Furthermore, no significant gender difference was found in the use of effective teaching strategies, whereas a significant disparity was found in perceptions of institutional support.

Research recommends that there is a need for hands-on, problem-based, and real-world STEM applications to sustain students' engagement and motivation in school. Further, multi-level collaboration, including schools, teachers, communities, and external STEM organizations, is required for better educational support. To improve STEM education in secondary schools of Quetta and other areas, further consideration is required on different areas such as investment in professional development, infrastructure, and innovative teaching methods.

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