



An Overview on STEM Education in Pakistan: Situation and Challenges

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Abstract

With the rapid development of the global economy and science and technology, STEM education has become an important strategy and approach for the cultivation of scientific and technological innovation talents and the reform of education and teaching in various countries worldwide. This study provides an overview of previous STEM education research studies carried out in Pakistan to clarify the current condition in STEM education in Pakistan. A qualitative research method was used to conduct this study, and 13 previous studies were selected (2008-2020) as the sample. Results indicate that STEM education practices by private sectors are visible more than the public sector. Moreover, it was found that there is a lack of laboratories, equipment, and other resources needed to teach STEM education. In essence, Pakistan's STEM education system is not adequately prepared and centered. There is an exclusive involvement needed by the government to support the efforts of all stakeholders, including the public and private. This study provides some suggestions for future research. Researchers need to design such a function that allows stakeholders to acquire necessary competencies relevant to STEM disciplines. Pakistan will have to overcome many challenges to achieve its goals before producing the STEM experts it needs effectively.

Disciplinary: Education Science & Technology, Human Development.

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1. Introduction

Science, technology, engineering, and mathematics (STEM) term is an emerging theme in contemporary education [1]. The term has mainly been driven to improve the competency and

competitiveness among schools and the curriculum. The concept has implications in the diversified sectors, such as developing the workforce and enhancing national security. However, the term is specifically used in addressing the education policy and curriculum [2]. With the rapid development of the global economy and science and technology, STEM education has become an important strategy and approach for the cultivation of scientific and technological innovation talents and the reform of education and teaching in various countries worldwide. Notably, the concept of STEM education is still emerging in Pakistan; nonetheless, concerning the other developed countries, the concept has prevailed significantly.

Education has been a concerning issue in Pakistan. As per the findings [3], one of the primary reasons behind the decline and low educational structure is the absence of adequate governmental policies that can empower this inadequate educational infrastructure. Though non-governmental bodies and other international organizations have also raised their concerns regarding the poor educational infrastructure and curriculum being applied from the primary and secondary education nonetheless, the only 46% literacy rate indicates how backward the country from the education standard perspective [4]. Furthermore, it can also be observed that the education sector of Pakistan is demonstrating inequality in the provision of education. The same duality in the provision of STEM education is also being observed in Pakistan.

1.1 STEM Concept and Pakistan Government and Private Companies

Pakistan's Ministry for Planning, Development & Reform conducted a seminar [5] and realized that increasing salaries had been the one issue for the public school teachers that restrict them to showcase their actual potential and science-based competencies. Nonetheless, it has also been realized that despite a significant increase in teachers' salaries, no significant change in public education has been achieved. This suggests that besides increasing teachers' salaries, there is a need to introduce teachers with an innovative and advanced teaching style with contemporary academic knowledge so that a more significant impact on the public school sector can be achieved [6]. As discussed, the government has now realized the importance of STEM education. In this regard, it aims to engage the Higher Education Commission and Universities to contribute prevailing the concept of STEM education in Pakistan in order to bring technology and innovative curriculum[7].

Further, A STEM Career Initiative was introduced by a joint partnership between the Higher Education Commission and the Pakistan Institute of Engineering and Applied Science (PIEAS) to enable young people and children to pursue their careers in science, technology, engineering, mathematics-based education. Besides government bodies and institutes like PIEAS, different private companies like TechTree, STEM Innovative Foundations, STEM Pakistan, and others are also playing contributory roles in elevating STEM education in Pakistan in the public and private sectors. For instance, one of the private company Tech for Pakistan, a movement started by the former Senator Usman Saifullah Khan along with Dr. Maria Rashid, promises young talent to a multiplier effect on the education system. The movement aims to recruit and train top graduates

from young professionals to teach low-income schools that lack quality education [8]. Further, one of the other private company STEM Visions, also aims to educate and re-educate young girls with STEM education [9]. STEM Vision also aims to provide free of cost STEM education to all the underprivileged kids of Pakistan.

An increasing field in developed and emerging countries is the convergence of science, technology, engineering, and mathematics, known as STEM education. [10]. STEM Education has appealed much attention from all over the world in recent years. STEM education is generally globalized: in the United Kingdom, Commonwealth countries like Pakistan follow patterns, while in the United States, European and Asian countries appear to follow growth. [11]. Currently, there is little literature on STEM education in Pakistan. Existing literature has shown some STEM Education practices mainly in private sectors; there were also a few STEM programs in some Pakistani universities, but they had not sustained. This research aims to describe the current status of STEM education in Pakistan.

1.2 Research Questions

RQ1. How were STEM education ideas first introduced in Pakistan?

RQ2. What is the current situation of STEM education in Pakistan?

RQ3. When introducing STEM education in Pakistan, what are the challenges?

This research contributes to enhancing the success of STEM education on the syllabus and conceptions in Pakistan, including the materials that provide to the students in different stages and qualifying for STEM education teachers in Pakistan. So, trying to increase the practical activities in this kind of education. This study highlighted the roles of Pakistani Ministry Education in this field and what does it should do for expanding STEM education and determined the benefits of STEM for education outcomes in Pakistan.

2. Methods

Based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), a qualitative research design was used to collect data (Figure 1) from many different online sources, including literature and non-academic literature. A search using variations and combinations of “STEM education,” “STEAM education,” “Science, technology, engineering, math,” and “Pakistan” as search terms were conducted in the Web of Science, ERIC, ProQuest, SpringerLink, and google scholar database. These keywords were used separately as the searching term included in the subject of the articles. From January 2008 to January 2020, the data were gathered through previous studies conducted in Pakistani STEM education, including dissertations, conference papers, book chapters, and published research articles at different stages.

Only 13 articles were selected for this research as a sample after determining the studies according to the criteria. One study for overview Education, three studies for primary education, five studies for secondary school, and four studies for undergraduate. Previous studies covered the

curriculum, teacher, students' activities, and the role of Pakistani government universities and organizations. This study analyzed and classified the studies that were a sample of this view paper.

Table 1: Summary of searched studies

Type	Number	Duration
Journal papers	18	2015 – 2020
Dissertations	3	2012 – 2017
Conference paper	4	2016 – 2018
Book Chapter	1	2008

For more explanation and details in this manuscript, the researchers arranged the studies, which were the sample of this study. Table 2 illustrated the characteristics of the articles.

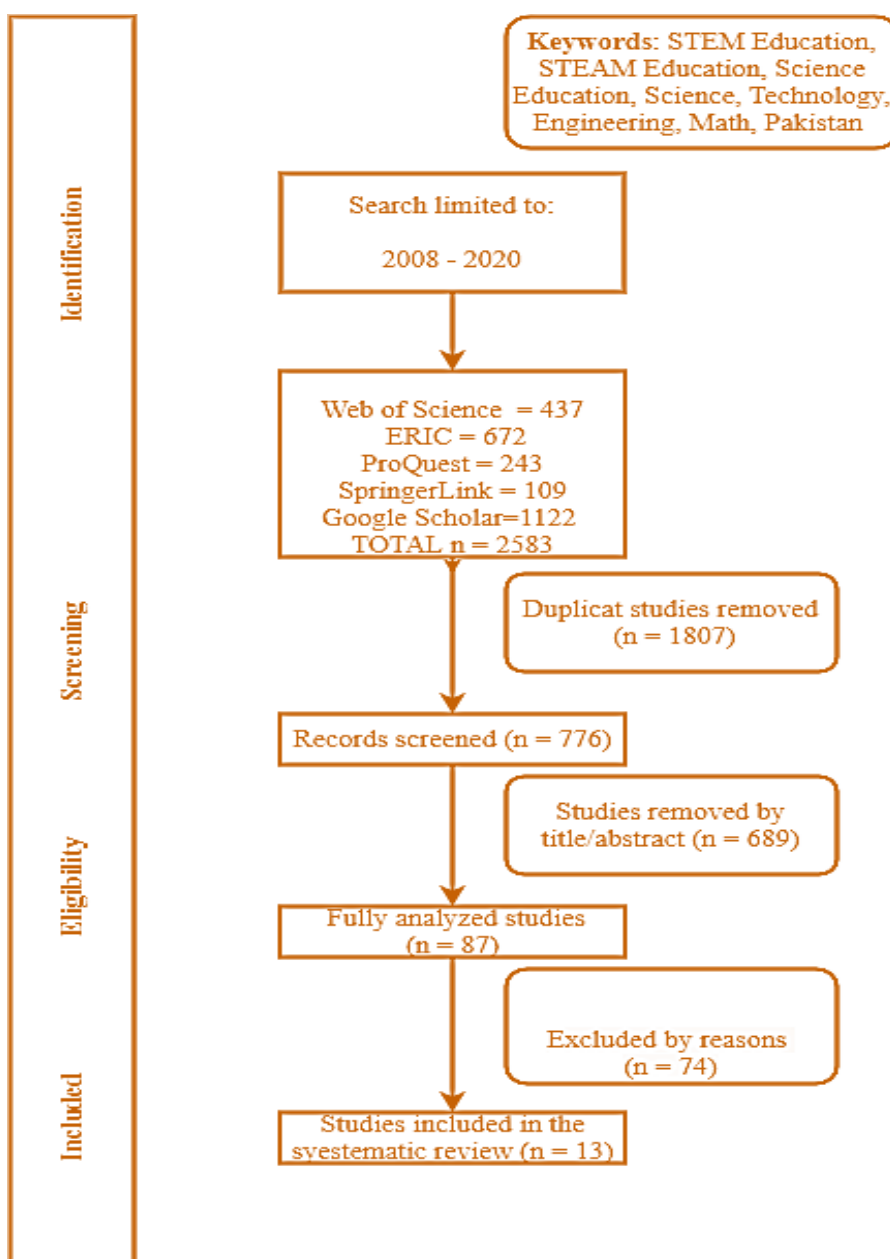


Figure 1: PRISMA Flow Diagram

Table 2: Characteristics of the included studies

Sr#	Article Title	Year	Type	Level	Instruments	Method
1	An Overview Of Science Teacher Education In Pakistan [11]	2020	Article	Overall	overview	Qualitative
2	Teaching Ethics, (Islamic) Values and Technology: Musings on Course Design and Experience [12]	2018	Conference Proceedings	University	Interview and survey	Mix
3	Robotics Education Methodology for K-12 Students for Enhancing Skill Sets Prior to Entering University[13]	2017	Conference Proceedings	K-12	Interview	Qualitative
4	Innovation in Education - Inclusion of 3D-Printing Technology in Modern Education System of Pakistan: Case from Pakistani Educational Institutes [14]	2017	Article	University	Interview	Qualitative
5	Interests and Recruitment in Science: Factors Influencing Recruitment and Retention in STEM Education at University Level in Pakistan [15]	2017	Article	University	Interview and survey	Mix
6	Design-Based Online Teacher Professional Development to Introduce Integration of STEM in Pakistan [16]	2017	Dissertation	6 to 8 grade	Interview and survey	Mix
7	Work in Progress: Shuffled Licht's Model of Learning for Teaching Mathematics Intensive Concepts to Undergraduate Engineering Students [17]	2016	Conference Proceedings	University	Interview	Qualitative
8	Challenges to High School STEM Education in Pakistan[18]	2016	Article	Secondary	Interview	Qualitative
9	STEM5: An Initiative Shaping the STEM Narrative in Pakistan[19]	2016	Conference Proceedings	K-12	Experimental program	Quantitative
10	The Millennium Development Goals Agenda: Constraints of Culture, Economy, and Empowerment in Influencing the Social Mobility of Pakistani Girls on Mathematics and Science Related Higher Education Courses in Universities in Pakistan[2]	2015	Article	University	Interview and survey	Mix
11	Science Education: Issues, Approaches, and Challenges [20]	2015	Article		Interview	Qualitative
12	ICTs in learning: Problems faced by Pakistan [21]	2013	Article	6-12 grade	Interview	Mix
13	Curriculum reform in science education in Pakistan [22]	2008	Chapter	4-12 grade		

3. Results

This study aimed to analyze the previous research studies regarding the STEM system. The analysis was sorted the articles depend on concerning and some studies' recommendations and that studies related to the critical needs and contributing to this field. Figure 2 gives the summarized study outcomes.

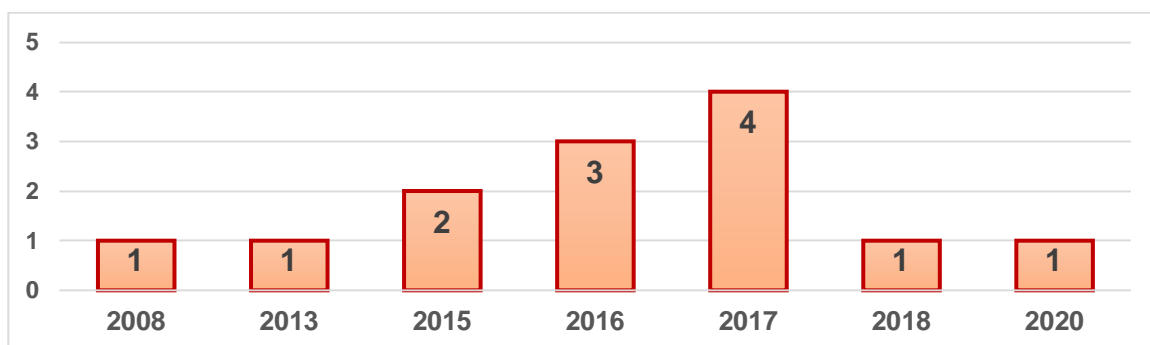


Figure 2: Year-wise number of studies (2008-2020).

There are several challenges facing STEM education in Pakistan like teaching competencies of STEM teachers, poor syllabus of STEM curriculum; student activities are not enough to achieve

whole goals of this type of education. STEM education practices by private more than public education. Therefore, there is a lack of laboratories, equipment, and other resources needed to teach STEM. The findings [12] have also suggested that this curriculum is more advanced and expensive in comparison with the conventional curriculum. Nonetheless, the outcomes from implementing this curriculum are yet to achieve, because STEM education in Pakistan has not prevailed comprehensively.

Moreover, it also becomes necessary to mention that the unfavorable economic conditions and industrial structure are also some constraints that are not helping this education in the country. However, the researcher has also suggested that soon as the country attains sustainability in its economic condition, there will be higher chances to achieve the desired outcomes and objectives of this curriculum plan [13]. The reason behind this is that with sustainability and development in the industrial sector, more STEM-based jobs can be generated. In developed countries, the concept of STEM education and that is designing the students' curriculum more centered on core subjects like Science, Technology, Engineering, and Mathematics has prevailed more significantly in comparison with developed countries like Pakistan, where the education structure is already declining [14].

The study has revealed that around 66% of schools going children (Figure 3) in Pakistan are enrolled in public schools. However, it becomes essential to mention that the education standard and infrastructure of the public sector is highly unsatisfactory. While accessing the level of STEM education in Pakistan, it becomes vital to consider the level of education and standard of the public school sector. It enrolls a more significant number of school-going students. Nonetheless, it has also been highlighted that the education curriculum and infrastructure in the public sector must be improved significantly. Furthermore, it has also been highlighted that the students going to the public schools in Pakistan have enough potential and skills to effectively compete with the students learning at privilege private schools [15].

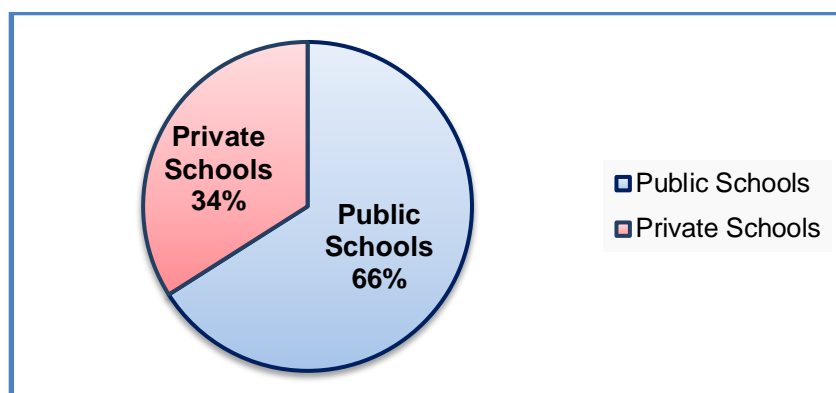


Figure 3: School-Going Children (%).

Improving the standard of STEM education in Pakistan through cross-disciplinary research, teaching, and syllabus collaborations so that future generations of educators and learners can

leverage appropriate STEM expertise and skills for themselves and others in addressing existing and emerging challenges. In essence, the STEM education system in Pakistan is not adequate. Most studies show that the Ministry of Education's efforts and ground-up activities by private and public organizations are exclusively involved and need to be sponsored.

4. Conclusion

STEM Education is the general word for curriculum in science, technology, engineering, and math. It is not, however, a generic term for specific subjects, but an education with realistic, extensive, transparent, and other features. It provides students with a bridge of opportunities to understand the world as a whole so that students can turn the scattered knowledge they have learned into a unified whole that is interconnected. It is an interdisciplinary learning method to eliminate obstacles in traditional teaching that separate knowledge of various subjects and are not conducive to the comprehensive solution of practical problems for students. STEM education in Pakistan is facing many challenges like teaching competencies of STEM teachers, poor syllabus of STEM curriculum, student activities are not enough to achieve the whole goals of this type of education. STEM education practices by private more than public education. Therefore, there is a lack of laboratories, equipment, and other resources needed to teach STEM. Pakistan needs sustainable development in the industrial sector; then, more STEM-based jobs can be generated. In essence, Pakistan's STEM education system is not adequately prepared and oriented, and the government needs exclusive participation to promote the efforts of all stakeholders, both public and private stakeholders.

STEM education plays vital roles in Pakistan's big challenge. For the records, we intended in this study to appear the reality of STEM education in Pakistan for many reasons. First, the Pakistani government has launched that kind of education and needed too many studies around this area for attempting to attain high-quality education and sustainable development. It might lead the Pakistani government to create a positive collaboration with other countries in the world. Second, STEM education should be cover all the learning stages and allocating the particular curriculum appropriating with available equipment and laboratories. Third, STEM education needs more support from the Pakistani Government to catch the fast growth in the world. Fourth, encouraging the researches in this field and provide the researchers with the data and information that pursuit to develop this kind of education in Pakistan.

5. Availability of Data and Material

Data can be made available by contacting the corresponding author.

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