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Science Teachers' perceptions Regarding STEM Education

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Abstract

STEM Education integrates Science, Technology, Engineering, and Mathematics. It emphasizes inquiry-based and student-centered learning, which are necessary 21st-century skills. The main purpose of this study was to examine Secondary school teachers' perceptions of STEM education. The participants of the survey were science teachers with different experiences in District Sargodha. The population was 1119 secondary school science teachers. The sample was selected using cluster sampling and proportionate sampling. The number of respondents in the sample was 300. It was a quantitative descriptive type of research in which a survey was carried out. Data was collected through questionnaires and data were analyzed through descriptive statistics. Key findings were that most of the teachers have a positive perception of STEM education. They considered it important to cope with the challenges of the 21st century. The challenge is the lack of training in STEM. Keeping in view the key findings, it was recommended that STEM education be implemented in private and public schools but there should be a proper curriculum for this. There should be a proper training program to train the teachers about STEM education.

***Keywords**:* Science. Technology. Engineering, Mathematics, Perception, Secondary school

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Introduction

In STEM education, students are directed to interconnect the disciplines of STEM. The role of the teacher in STEM education is very important. The teacher directs students to explore and clarify the problem by asking several questions. STEM education is student-centered learning. Teachers use questioning strategies to encourage students to use higher order thinking skills so they can solve STEM challenges in a precise manner. Secondary teachers play a vital role in the development of STEM talent among students (Margot & Kettler, 2019). According to Gulcan, Yilmaz & Caglar (2017) STEM is the transformation of theoretical knowledge into practical knowledge. STEM is not just a term; it is an approach that transforms theoretical knowledge into practical education. It creates opportunities for discoveries and innovative solutions.

STEM is not merely an acronym, technique or model, but it is an attitude towards the constructive educational system that leads the students from theoretical knowledge to the practical aspects of science, technology, engineering and mathematics. Hence, the role of teachers is very crucial, particularly at the Secondary level. They can integrate the STEM-based curriculum and, with their teaching techniques and approaches, make it possible to integrate STEM education to the regular system of education (Khan, 2020). The way through which teachers comprehend STEM education needs to be determined.

For the professional development of teachers in STEM education, it is necessary to investigate the existing competencies among them. A teacher who possesses these basic STEM skills is very likely capable of doing justice in STEM education. The constitution of Pakistan describes that the integration of science and technology is the responsibility of the Federal Government. The Ministry of Science and Technology is the primary agency to implement STEM education Policy. STEM education can be incorporated into the national curriculum. It will raise the standards of teaching and learning, assessment, and improvement in schools and higher educational institutions. It is the need of every child to master STEM skills to develop problem-solving skills, critical thinking, collaboration and computational thinking skills (Al'Abri, 2011).

Literature Review

In STEM education, the subjects of Science, Technology, Engineering and Mathematics are learned in an integrated manner during teaching and learning methods. Hence, students taught by using this approach will be inventors, self-confident, logical thinkers and

technically literate (Hasanah, 2020). The effectiveness of STEM education depends on the curriculum and teaching in science and math, an integrated approach, problem-solving skills, inquiry-based learning, collaboration, multi-prospective viewpoints, investigating learning experience with the help of technology, practical application of science and engineering and utilizing project-based learning and problem-based learning (Kennedy & Odell, 2014).

The 21st century generation requires being a critical thinker, creative, collaborative, and cooperative. These skills help STEM teachers carry out design projects in STEM education. Berland (2013) is of the view that observation, gathering facts, asking questions, verifying explanations and decision-making skills are needed while teaching the contents of these disciplines. Students should possess the skills to find facts and realities, applying tools and technology for gathering data, enabling them to make predictions and produce results. Inquiry-based learning is one of the most needed benchmarks to integrate higher-order thinking skills among learners (Forawi, 2016).

The success of STEM Education depends on a rigorous curriculum in science and mathematics, applying engineering designs and problem-solving skills, utilizing the inquiry strategy in all disciplines of STEM education, interfacing with the community, developing interdisciplinary concepts, and applying project-based learning, problem-based learning and inquiry-based learning. These learning skills are in high demand to get STEM jobs. Berland (2013) suggested rules through which the learners can use instructional design effectively: testing students with STEM education problems, making distinct learning goals, engaging students in discussion to attain their goals and the design process that they need to approach. These skills are major components to achieving any task (Bybee, 2013).

The implementation of STEM instruction requires a well-managed, established and profound structure of curriculum. STEM instruction also requires lot of materials and numerous resources. Moreover, scientists, engineers and technical experts are needed to train teachers for various disciplines of STEM instruction (Permanasari et al., 2021; Sanders, 2009).

Teachers' Perceptions of STEM Education

Teachers' perceptions can be defined as "the way through which teachers conceptualize the contents and interventions in the classroom in accordance with students' learning" (Grant, 2002). Teachers' perceptions are shaped by their own beliefs and prior experiences. Usually, teachers follow the pattern in which they were taught. Most of the teachers use teacher-centered approaches in the classroom because they were taught

by using the same strategy. The teaching practices of teachers reflect their underlying beliefs. As most of the teachers, particularly at the Secondary level, are reluctant to accept the new challenges and strategies so it is very challenging to determine their beliefs about STEM education (Anggraeni & Sole, 2020).

There is a strong relationship between teachers' perceptions of the integrated curriculum and their beliefs about STEM subjects. Through their perception, teachers can justify whether they can implement STEM in their classrooms or not. Few researchers focused on the teachers' perceptions of integrated education and its practices in the classroom. Science and math teachers are of the view that both these subjects are related naturally. Some researchers show that engineering is not accessible to many students, particularly girls and minorities (Wang, 2012). Hence, the higher-order skills like problem solving can be integrated into students (Mankash & Kazmi, 2021). It also encourages teachers to make their students learn by doing. The teachers should be skilled with this pedagogy. The International Society for Technology in Education has described the standards that are crucial for STEM education. These standards are as follows:

- Creativity and originality
- Communication and collaboration
- Critical thinking skills, problem-solving skills, and conclusion-making
- Digital thinking skills
- Data analysis, mastery of research methods
- Conceptualization

These standards are required for a STEM teacher. The core of STEM education is a balanced combination of technology, science, math and engineering in one curriculum. First, the basic professional capabilities must be determined among teachers to enable them to teach STEM education (Qadir & Suleman, 2018). The reform of STEM education relies on the teachers. It is very critical to determine the attitude and perceptions of teachers toward STEM education. The teachers' understanding of the significance of STEM education paves the path for the integration of STEM education. This depends heavily on the competencies and abilities of science teachers.

Teachers must be aware of the reforms in the 21st century. Teachers must integrate the latest reforms of education in their classrooms. Teachers must improve their capabilities to adopt new teaching techniques. The structure of STEM classrooms is quite different from the traditional classroom. Teachers must possess such abilities that could

bring a new instructional technique. They also need to have a strong understanding of STEM pedagogical content and skills to adopt STEM effectively. Teachers' perceptions have a great impact on their behavior and performance. Because of better perceptions, motivated teachers will reflect a stronger sense of adopting STEM education (Boon, 2019).

In this modern era, teachers need to have a good knowledge of STEM careers to guide students towards their professions (Mankesh & Kazimi, 2021). The review of literature provides a detailed overview of STEM education and its status in Pakistan. The significance of teachers' perceptions and the challenges that hold back the execution of STEM education in Pakistan are also highlighted. The current research focused on the teachers' perceptions regarding STEM education at the secondary level in public schools of Pakistan.

Statement of the Problem

Landscape is changing frequently, and the emergence of new challenges and demands is evident. Science education is looked at to keep abreast of meeting these demands and challenges. All developed countries are forefront of meeting the challenges through education, particularly science education. STEM education has been considered as one of the essential reforms in education throughout the world and a tool for meeting the challenges of unemployment, which is due to a lack of soft and hard skills. Many countries of the world have adopted STEM education in their schools, particularly in developed countries.

Skills development is very important for students today. National Educational Policy 2009 laid emphasis on developing critical thinking, problem solving, communication and technical skills among students. STEM education is one of the best platforms to develop integrated skills among students and for better success in real life. Initiatives of STEM education in Pakistan show that STEM education is necessary for developing these skills and for getting reasonable employment.

There is little empirical evidence about how science teachers perceive STEM education and its approaches. The perceptions of science teachers regarding STEM education have not been well documented in Punjab. Therefore, the researcher intended to find out the Perceptions of Science teachers regarding STEM education in District Sargodha.

Significance of Study

Keeping in view the trends of STEM education throughout the world, it is urgently required in developing countries like Pakistan. This research focused on the perceptions of teachers regarding STEM education for the awareness of STEM education at the secondary level,

particularly in public schools. This study also aimed to explore the perceptions of teachers about the recent practices, significance and support required for STEM education. The study provided a deep insight into the teachers' beliefs, awareness and readiness to adopt STEM approaches in their pedagogy. The findings of the study may fill the gap found in the literature review.

The study is an attempt to find the perceptions of secondary school science teachers in the public sector. Review of literature may help teachers, students and parents to understand the importance of STEM education. Keeping in view the trends of STEM education in the world, this research may provide guidance to authorities to implement STEM education in schools.

This research has contributed to addition of knowledge. Findings of this research may raise awareness of STEM education and role of teachers in its success, and public may invest to promote STEM education among their children.

Objective of the Study

Examine secondary school science teachers' perceptions regarding scope of STEM education in Pakistan.

Research Question

1. What are secondary school science teachers' perceptions about support that would improve the awareness of STEM education?

Research Methodology

Quantitative approach was the best approach for this study as the quantitative data was used for data analysis, finding results, and generalizing results to a wider range. A survey was conducted with secondary school science teachers. To determine teachers' perceptions regarding STEM education, a questionnaire developed on a five-point Likert scale was used. The questionnaire aimed to collect teachers' perceptions about different aspects of STEM education. The purpose of this study is to determine information about science subjects' teachers' perceptions of STEM education. The results were analyzed to offer further explanation.

Research Design

A descriptive research survey method was used. The research was quantitative in nature. Quantitative research is used widely for natural and social sciences. The focus of this study is to find out secondary

school science teachers' perceptions regarding STEM education. The demographic information of teachers was collected through a form given to each participant. The investigations for teachers' perceptions were done quantitatively. A questionnaire based on a five-point Likert scale was used. The survey was done with 300 participants to investigate how secondary school science teachers perceive STEM education. The questionnaire was distributed by the researcher herself. The respondents were invited to complete the questionnaire, and the data were collected in the same manner. After statistical analysis of the questionnaire, the data were interpreted.

Population of the Study

The context of the study was District Sargodha, Punjab. In terms of population, Punjab is the largest province of Pakistan. It also has the highest literacy rate of 64.7% (FDGOP, 2019) and the largest share of 54.1% in the economy. Out of 58 cities in Punjab, Sargodha was selected randomly. All Public Sector Science teachers teaching at the Secondary level in all seven Tehsils of the district Sargodha were the population of this study. According to the School Information System (SIS) Punjab, the total number of secondary school science teachers in District Sargodha is 1119.

These include the teachers of mathematics, physics, chemistry, biology and computer science (IT) in the public sector of District Sargodha. The reason to choose teachers at the secondary level as the population of this study is that options for subject selection for students are available here and it continues to increase as the level increases. After the secondary level, science students have to opt for choosing medical, engineering, or computer sciences. The concern of students for choosing subjects becomes more visible (UNESCO, 2017). It is also investigated through several studies that spatial skills that are developed up to the elementary level can promote students' interest in STEM education when they are at the secondary level. The science teachers at the secondary level can perceive in a better way whether STEM education should be implemented or not. The teachers are aware of the ground realities, the obstacles, the schools' infrastructure and other elements required for STEM integration. The most important factor is that at the secondary level, the students are prepared by the teachers for their working careers and professions. The secondary level of the school is like a crossroad that opens the way towards the higher secondary and degree levels. Skilled manpower is provided for several professions after the completion of degrees.

Sample and Sampling Technique

The study followed a multistage sampling technique. Furthermore, cluster proportionate sampling was adopted. The total population of the study consisted of 1119 secondary school science teachers. The strategy of research determines the sampling techniques. Hence, to cover the age population, it was necessary to make a cluster of each tehsil of District Sargodha so that teachers from all tehsils of District Sargodha could give their perceptions regarding STEM education. The seven clusters were made. Each cluster represented one tehsil.

In the next phase proportionate sampling technique was used. Using Krejice and Morgan Table (N=300, S=280) 30% science teachers were selected from the total number of secondary school science teachers in every tehsil. Hence, the number of teachers from Tehsil Sargodha was 165, Tehsil Silanwali 142, Tehsil Shahpur 30, Tehsil Sahiwal 29, Tehsil Kot Momin 23, Tehsil Bhera 18 and Tehsil Bhulwal 29. Hence, the total sample consisted of 308 secondary school science teachers.

Table 1

Population and Sampling of Study (Krejice and Morgan Table)

Name of Tehsil	Total number of SSTs Science	Sample @ 30%
Sargodha	551	165
Silanwali	142	43
Shahpur	100	30
Sahiwal	96	29
Kot Momin	75	23
Bhera	59	18
Bhalwal	96	29
Total	1119	308

Results

This study determined STEM-related subjects' teachers' perceptions of STEM education in the secondary schools of Pakistan. The perceptions of secondary school science teachers were collected through a structured questionnaire. The first section of the questionnaire was the demographic data; the demographic information included experience, the major aspects of teaching, and the subjects taught by the teacher. The questionnaire was distributed among 308 teachers who teach science subjects (Biology, Chemistry, Physics), Computer Science mathematics at the secondary level in schools. Some of the respondents refused to fill out the forms. The questionnaire was filled in front of the researcher by 300 teachers.

Analysis of Perceptions Regarding Disciplines of STEM

Table 2

Analysis of Teachers' Perceptions about STEM Disciplines and Interdisciplinary Approach of STEM Education

Statement	SA %	A %	U %	D%	SD %
STEM can be taught as an interdisciplinary approach.	37	61	1	1	0
Incorporation of science, technology, engineering and math is essential at the secondary level.	54	38	2	5	1
The subjects of science and Mathematics can be integrated easily, as compared to technology and engineering.	26	57	12	5	0
Math is a foundation for STEM education for active and collaborative learning.	35	44	16	5	0
Teaching engineering at the secondary level helps students to solve real-life problems.	25	55	7	10	3

The table illustrates the results of the first objective of the research. For the first construction of the questionnaire that represented the disciplines and interdisciplinary approach of STEM education, questions 1-5 were included. For the first question, strongly agree and agree responses were 98%, for question two 92%, for question three 83%, for question four 89% and for question five 80% respondents strongly agree or agree.

Conclusion

STEM education has been considered as one of the crucial reforms in education throughout the world. Many countries of the world have adopted STEM education in their schools, particularly in developed countries. National Educational Policy 2009 emphasizes developing critical and communication skills among students. It is also mandatory to create such a learning environment that is conducive and full of innovations. The approaches of STEM education enhance the strategies of problem-based learning, project-based learning and inquiry-based learning.

Teachers play the main role in steering the learning and developing the skills among students. The way in which teachers perceive STEM education in Pakistan will surely affect the integration and application of STEM education in Pakistan. STEM education is urgently needed to

develop 21st-century skills among students to gain a stable economy in developing countries like Pakistan. There is an obscurity about STEM integration and implementation in Pakistan. Research was needed to find out teachers' perceptions of STEM education; therefore, the current research intended to study the Science teachers' perceptions about STEM education in the Secondary schools of Pakistan.

Science teachers in Pakistan encounter many difficulties in adapting new reforms in their classroom because of lack of knowledge and experience. Highly developed STEM education professional development programs are urgently needed.

Teachers work as a catalyst to foster the capabilities of students. In any educational system, teachers play a key role. The perceptions, beliefs and attitudes of teachers are strongly reflected in their teaching practices. To integrate and implement STEM education in Pakistan, it is very necessary to find the teachers' perceptions towards it. The study worked for the same purpose. The research found that teachers have positive perceptions of STEM education in Pakistan. They are aware of the challenges of the twenty-first century, and they desire to develop these skills among their students. By implementing a comprehensive curriculum, consistent professional development and improving the infrastructure of secondary schools, STEM education can be successfully implemented in the public schools of Pakistan. The findings of the study can be concluded as follows:

1. STEM education can be taught as interdisciplinary approach. A well-planned curriculum based on the disciplines of STEM education might be formulated for the secondary school science students. The subjects of technology and engineering can be introduced at the secondary level to make students familiar with the contents as well as to make them more skillful.
2. Teachers believe that STEM education can enhance motor skills, learning by doing, develop social and cognitive skills, and is career-oriented. There is a huge gap between academic qualifications and market demand. To bridge this gap, STEM education can be implemented.
3. To improve the efficacy of secondary school science teachers, it is highly recommended that there be a well-planned professional development program for secondary school science teachers. Pre-service, in-service training, workshops and seminars regarding STEM education can foster the skills of teachers and they can be well capable of teaching through the approaches of STEM education.
4. The findings of the study showed that our students have the potential and capabilities to grasp the innovative methods of learning. Critical thinking skills, problem-solving skills, teamwork etc. should be learned at the secondary level to take full advantage of STEM education.

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