Science Teachers' Beliefs and Understanding of Stem Education at School Level

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Abstract

STEM Education refers to the study of science, technology, engineering, and mathematics. Teachers think STEM education is crucial for the future success of their students as it is an interdisciplinary approach to learning removes barriers in conventional instruction that divide knowledge of multiple areas and prevent students from coming up with comprehensive solutions to real-world situations. This research paper was designed to know science teachers' beliefs and understanding of STEM education at school level. To collect data, a questionnaire was used which consisted of 44 items with six factors about teachers' beliefs and understanding about STEM education. The sample was selected using a simple random sampling technique. 57 teachers of District Jhang responded the questionnaire. Collected data was analyzed using statistical techniques. The objectives of the study were; a) To identify science teachers' current beliefs and understanding towards STEM education. b) To learn about opportunities and obstacles associated with implementing STEM education. c) To evaluate the need for professional development in STEM teaching. d) To ascertain how STEM education will be implemented in classrooms and what effects it will have on students. e) To determine the STEM education's potential future in Pakistan. It was concluded that STEM education helps students develop 21st century skills as well as for better future and there is need of professional developments to better implement STEM education. It was concluded that STEM education is evolving over the next decade. It was concluded that there were lack of resources to implement STEM education. It is recommended that STEM-related teacher trainings should be done. Schools should be reorganized and curriculum needs to be updated to reflect the evolving needs of STEM education. Additionally, the community and school administration should assist teachers in adopting STEM education.

Keywords: Beliefs; Understanding; STEM education; Science teachers

Introduction

In recent years, STEM education has become increasingly important to enhance student learning and better prepare students for the workforce of the twenty-first century. Teachers think STEM education is crucial for the future success of their kids. According to research conducted by the National Science Board in 2018, "students who are proficient in STEM are more likely to graduate from high school, attend college, and earn higher salaries than students who are not proficient in STEM." Initiatives of STEM integration are supported by the teachers across the curriculum. According to some research studies from 2015, the majority of teachers (80%) believed that STEM education should be integrated across the curriculum. There were concerns about STEM education which were raised by the teachers and include lack of time and resources, lack of STEM teacher trainings, challenges in integrating STEM education across the curriculum, and lack of student motivation (Zhao et al., 2022). According to a research conducted in 2016 by the National Science instructors Association, the most common challenges that teachers faced in teaching STEM were lack of time, lack of resources, and lack of teacher trainings. The Bill & Melinda Gates Foundation conducted a research in 2016 that resulted in teachers' believes that STEM education could help students develop the skills they need to be successful in college and careers. STEM education aims to help students in developing their critical thinking, problem-solving, creativity, innovation, and teamwork skills (Bybee, R. 2013).

There are teachers' perceptions, attitudes, and opinions towards the teaching and learning of science, technology, engineering, and mathematics disciplines, which are referred to as their understanding and beliefs about STEM education. The opinions of teachers on the value of STEM education, the effectiveness of the instructional strategies and curricula, teacher' confidence and competency in handling STEM subjects, and their perceptions about STEM education play important role in preparing students for future employment. These are just a few examples of ideas and understanding of teachers. In addition, the attitudes and understanding of teachers could change depending on each teacher's unique experience, circumstances, and professional development. The benefits of relating STEM principles to practical applications and situations are widely acknowledged by the teachers. According to them, giving students real-world experiences will help those students understand the importance and applicability of STEM education (Dare et al., 2021).

STEM education is playing important role in educating students for their future, nurturing their problem-solving abilities, boosting their technology literacy, stimulating their innovation, and resolving their global concerns. It is also crucial to generate economic growth. Societies can produce workforce with all the skills required for the success in this modern world by prioritizing STEM education. Various studies and their reports have examined teachers' beliefs and understanding of STEM education till now. It is significant to keep in mind that these findings might not accurately reflect the opinions of all teachers and may differ depending on the context, location, and individual experiences. It is essential for people to be digitally literate in the modern digital world. Students who receive a STEM education are better prepared to use and comprehend technology (Land, 2013).

People with 21st-century abilities, such as critical thinking, entrepreneurship,

communication, cooperation, decision-making, leadership, problem-solving, responsibility, and creativity, are in demand in the modern world. The STEM method is one of the educational philosophies that supports these students (Akiri et al., 2021; Siregar et al., 2019). The National Science Foundation head J. A. Ramaley initially mentioned STEM in 2001, and it took off from there (Hassan et al., 2022). Science, technology, engineering, and mathematics, or STEM, is an acronym used in education. Despite the fact that the STEM approach primarily comprises of the four major elements described above, the art element has been introduced to these disciplines in recent literary studies. This new approach is known as STEAM or STEM + A. STEM, sometimes known as science, technology, engineering, and math, is an abbreviation used in education. Even though the STEM approach mostly consists of the four main components mentioned above, the art component has recently been added to these fields through literary studies. STEAM, or STEM + A, is the name of this novel strategy. In contrast to the normal STEM approach, which focuses more emphasis on the development of analytical thinking skills, the STEM + A education technique, according to Land (2013), lays equal emphasis on the development of analytical and creative thinking skills. However, it's common practice to neglect teachers' perceptions and beliefs while developing their strategies and procedures for implementing new educational reforms (Madani, 2020).

The collaborative character of STEM education is valued by teachers. They understand that working in groups and collaborating on STEM projects fosters interpersonal, communication, and teamwork skills, all of which are crucial for success in the workforce of the twenty-first century (National Research Council, 2012). Teachers frequently mention difficulties in putting successful STEM instruction into practice, including a lack of resources, a lack of time, and the requirement for continual professional development. To improve their STEM teaching strategies, they emphasize the value of support and professional development opportunities (Bybee, 2013).

There are a few variables like teachers' training, their professional experience, their personal opinions, and societal conventions that may have impact on teachers' understanding and attitudes. It is important for schools to provide better STEM education and to encourage students to accomplish STEM education so that they may understand teachers' attitudes toward the STEM subjects. There is need to establish effective policies and programs in order to advance STEM education. It can be done by research on teachers' perspectives in order to better understand their needs for professional development (Yldrm and Altun, 2015).

There is need to better understand the factors by research studies that affect teachers' teaching practices by examining their perceptions of STEM education, including their attitudes and understanding towards using technology in teaching STEM education in the classroom, their perceptions of how important STEM subjects are to students' future success, and their understanding about the relevance of STEM subjects to the success of students (Costa et al., 2022). In addition, it is important to know what teachers think and understand about STEM education, so that they can serve to shape the creation of educational interventions and programs as well as play important part in policy decisions. For example, policy makers may think about giving more resources to promote STEM education; if teachers have concerns about the lack of resources or professional development opportunities available for teaching STEM courses. In general, this study of teachers' perceptions and knowledge of STEM education was conducted to better understand the challenges and

opportunities of teaching STEM subjects, as well as to create strategies and techniques that may help students receive better STEM education (Kelley and Knowles 2016).

Problem Statement

For an effective teaching-learning process and quality education, it is important to identify any challenges or issues that may prevent teachers from properly teaching STEM education in their classrooms, this study was set out to investigate the existing beliefs and understanding of science teachers in Pakistan concerning about STEM education. So, it was necessary to assess the persisting beliefs and understanding of science teachers in Pakistan. By tackling these problems, we can improve the standards and applicability of STEM education in Pakistan and can make sure that students are ready for the challenges of the future as well as the challenges of fast evolving job market. This research study was important to know teachers' present beliefs and understanding of STEM education, the potential and difficulties associated with implementing it, professional development support, STEM teaching techniques, and the future of STEM education in Pakistan.

Justification of the Study

Some research studies believe that STEM education is important for preparing students for the evolving job market trends and the nation's economic future, other studies believe that it is challenging to teach and is not particularly relevant to their students (Margot 2019). The relevance and significance of STEM education may also be viewed differently by some teachers due to a lack of resources or inappropriate professional preparation for teaching STEM courses. The beliefs and understanding of teachers can offer important insights into how they approach their profession, what techniques they employ to engage and inspire students while teaching STEM education, and how they deal with difficulties in their classrooms. Researchers can highlight areas where teachers may need professional development by knowing their beliefs and understanding. Additionally, knowing what teachers believe and understand may help to make educational interventions and programs as well as policy decisions. Researchers can better understand those factors that affect teachers' teaching practices by examining teachers' perceptions of STEM education and better understand the challenges and opportunities of teaching STEM subjects, as well as they can help create techniques that may help students receive better STEM education in future.

Objectives of the Study

The following were the basic objectives of the study;

1. To identify science teachers' current beliefs and their understanding about STEM education.
2. To learn about opportunities and obstacles associated with implementing STEM education.
3. To evaluate the need for professional development and training in STEM teaching.
4. To ascertain how STEM education will be implemented in classrooms and what effects it will have on students.
5. To determine the STEM education's potential future in Pakistan.

Research Questions

The following were the research questions of the study;

1. What are science teachers' current beliefs and understanding of STEM education?
2. When introducing STEM education in Pakistan, what are the obstacles?
3. Does Pakistan's STEM education require professional growth or training?
4. What do teachers believe about the methods for implementing the STEM approach in their classrooms?
5. How will STEM education develop in Pakistan?

Research Methodology

The study was quantitative; survey method was used; the aim of the study was to identify the scientific teachers' perspectives, and their knowledge of STEM education at school level. The researcher conducted this research in district Jhang and selected sample from 240 science teachers employed by the district of Jhang school education department, including primary school teachers (PSTs), elementary school teachers (ESTs), secondary school teachers (SSTs), Headmasters (HMs), and subject specialists (SS). Data was collected with a 5-point Likert scale consisting of 44 questions; the questions were about science teachers' beliefs and understanding of STEM education, challenges and opportunities in implementing STEM education, their need of professional development, STEM teaching techniques and future of STEM education; after data collection, data was analyzed through different statistical tools like mean, standard deviation and t-test and ANOVA. The sample for the study was randomly selected from science teachers employed by the district of Jhang school education department. Following the guidelines in Krejcie and Morgan's (1970) table, 57 respondents from District Jhang government schools were chosen for the research purpose using simple random sampling technique as samples.

Development of Tool

The research tool was survey questionnaire and it had 44 items, including 6 sections; (a) beliefs about STEM education, (b) understanding about STEM education, (c) possibilities and challenges, (d) professional development and support, (e) STEM teaching techniques, and (f) the future of STEM education. A 5-point Likert scale, from strongly disagree to strongly agree, was used to score the items.

Reliability and Validity of Tool

Tools were developed before expert panels, and suggestions were followed according to the context of understanding science teachers' ideas and understanding about STEM education at the school level. The tool was pilot tested on 15 teachers, who were then excluded from the sample selection. The reliability of the tool was .90, which was excellent.

Findings of the Study

Table 1 Factorial Data Analysis

Factors	*f*	μ	σ	T	A
Beliefs about STEM Education	*56*	3.9333	.98658	30.100	.000
Understanding about STEM Education	*56*	3.8386	.50063	57.889	.000

Challenges and Opportunities	*56*	3.6199	.58057	47.074	.000
Professional Development and Support	*56*	3.8918	.61439	47.824	.000
STEM Teaching Strategies	*56*	4.0263	.59889	50.757	.000
Future of STEM Education	*56*	3.8211	.52737	54.702	.000

Table 1 describes the data analysis of factors; it was found that the mean of factor beliefs about STEM Education was (3.9333), the standard deviation was (.98658), the t-test was (30.100), $p< 0.05$. It was explored that the mean of factor understanding about STEM education was (3.8386), the standard deviation was (.50063), the t-test was (57.889), $p< 0.05$. It was observed that the mean of factor challenges and opportunities was (3.6199), the standard deviation was (.58057), t test was (47.074), $p< 0.05$. It was explored that the mean of factor professional development and support was (3.8918), the standard deviation was (.61439), the t-test was (47.824), $p< 0.05$. It was observed that the mean of factor STEM teaching strategies was (4.0263), the standard deviation was (.59889), t test was (50.757), $p< 0.05$. It was also explored that the mean of factor future of STEM education was (3.8211), the standard deviation was (.52737), the t-test was (54.702), $p< 0.05$.

Conclusion

It was found that science teachers had belief and understanding that STEM education could give students the chance to enhance their research and inquiry skills. It was concluded that there is a lack of resources for STEM education in most of the schools. Mostly teachers feel supported by school administration in implementing STEM education and that support can help improving quality education. It was found that in order to raise awareness of STEM education; teachers need professional development or trainings in the field (at least one per year). Although mostly teachers were not familiar with the use of active learning techniques and strategies in their teaching towards STEM education but when implemented, students actively responded to STEM activities in the classroom and STEM education resulted in improved student performance. It was also concluded that schools should be restructured, teachers should adapt themselves to meet the changing demands of STEM education and curriculum should be revised. It will help shape future of students as well as result in development of economy of the country.

Recommendations

The following recommendations were made according to the conclusions;

i. STEM-related teacher professional development and training should be done. Teachers need to modify their practices to meet the evolving needs of STEM education.
ii. In order to satisfy the evolving needs of STEM education, schools should be reorganized and curriculum needs to be updated to reflect the evolving needs of STEM education.
iii. When implementing STEM education, teachers should draw linkages between STEM concepts and practical applications. The community and school administration should assist teachers in adopting STEM education.

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