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TEACHERS' PERSPECTIVES ON THE BENEFITS AND ROLE OF STEM EDUCATION IN THE SOLUTION OF COMPLEX GLOBAL CHALLENGES

Qaisar Abbas [1,*], Khalida Parveen [2], Misbah Rehman [3], Shazia Tabassum [3] and Dawood Ahmed [3]

[1] *Department of Teacher Education, The Shaikh Ayaz University Shaikarpur, Sindh Pakistan*
[2] *Qujing Normal University, Yunnan, China*
[3] *Department of Education, The University of Faisalabad, Pakistan*

ABSTRACT

The globe on which we live faces a lot of complex challenges. The world of the 21st century needs some particular skills based on science, technology, engineering, and mathematics (STEM) in order to solve complex global challenges. This research aimed to assess teachers' perspectives on the benefits and role of STEM education in the solution of complex global challenges. This research was descriptive. All the government secondary school teachers of Faisalabad Division of Pakistan were the population, and a sample of 100 teachers was selected from them through a convenience sampling method. A Likert-based, closed-ended questionnaire with 13 statements was developed for data collection. The validity of the questionnaire was confirmed by obtaining the experts' opinions, and reliability was ensured through pilot testing. The data were collected by the researchers, and the same were analyzed in SPSS, where descriptive as well as inferential statistics were applied. Results revealed that the majority of the government secondary school teachers had a higher level of agreement with the benefits of STEM education, such as that it increases the critical thinking skills of the students, develops innovation and curiosity in students, improves cognitive skills, develops problem solving skills, and makes them responsible citizens. Results found that teachers also had a higher level of agreement towards the role of STEM education in the solution of global complex challenges, such as developing students' understanding of real world problems, applying STEM knowledge to tackle global challenges, enabling students to eliminate pollution around the planet, equipping students to discover sources of renewable energy and water, enabling students to propose novel agricultural and food production techniques, enabling students to deal with social and medical problems at the national and international level, and preparing students to find solutions to problems on a global scale. The study recommends that a STEM educational approach be implemented from primary classes to higher education in order to equip students with STEM skills to tackle the complex global challenges.

Keywords: STEM education; Benefits; Complex global challenges; Secondary teachers.
** Email: drqaj@yahoo.com*

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INTRODUCTION

The world is facing more complicated problems than ever before, like finding a cure for COVID-19, dealing with global climate change, and making sure our planet has enough water, food, and energy. There is a lack of solutions for these problems in the existing textbooks and curricula. All societies need some individuals who solve these problems in a creative and innovative way. According to Michael et al. (2018), STEM professionals are in high demand because they are essential to solving problems that actually occur in the real world. The majority of the world's sociological, economic, and environmental problems can only be solved if the workforce is focused on science, technology, engineering, and mathematics (STEM) sectors

(UNO, 2012). The one purpose of education is to provide learners with the knowledge and skills necessary to address challenges and concerns posed by everyday life. The main duty of educators is to create learning activities that equip students with the abilities needed for problem-solving and foster their development as creative thinkers. The key is to create a learning scenario that places a real-world challenge in front of students and asks them to think creatively by applying their answers, designs, or ideas to audiences outside of the classroom. Therefore, teaching in the STEM fields, everyday living skills, understanding of the natural world, and morals and ethics should all incorporate enculturation of their respective component parts. According to the OECD's 2030 vision, the economy-based revolution will require an education system change. According to the OECD's concept of education, schools must prepare pupils for unanticipated jobs, technologies, and social concerns. Therefore, educational policy should focus on reorganizing schools around STEM-based teaching methods in order to achieve these goals (Kalkan, 2022).

According to UNESCO (2018), people are the primary cause of the majority of local and global environmental changes occurring today. New technology, natural disasters, climate change, and pandemics all have a significant impact on people's economic stability and well-being, both now and in the future. The relationships between the components of biophysical, technological, and human systems are complex and evolve over time, as do interactions between individuals and their settings. People struggle to find a secure environment in which to grow as a result. This frees up space for education, a crucial component of preparing young people for today's and tomorrow's social, economic, and environmental challenges, including global climate change, digitalization, and globalization. Young people should receive an education that takes into account the reality of these issues since the world is interconnected, dynamic, and difficult to understand, as well as because there are global concerns. It is obvious that we need education that contributes to a more sustainable world since it can improve people's lives and promote sustainable development.

It is worth mentioning that for sustainable development, education was the subject of the UN's fourth Sustainable Development Goal (SDG) (United Nations, 2015). A key strategy for accomplishing the SDGs is education. The creation of curriculum, teacher preparation programs, learning resources, and learning environments are all influenced by educational policies, which are crucial towards the successful implementation of education for sustainable development (UNESCO, 2018). Every SDG calls for education to equip people with the knowledge, skills, abilities, and values they need to advance themselves and benefit society. In this environment, STEM education appears to be crucial for preparing the next generation to tackle the problems facing humanity.

According to Bissaker (2014) and Sanders (2012), STEM education is an innovative method of teaching and is widely included in the world's system of educational policies and reforms. According to Chesky and Wolfmeyer (2015), STEM education is a multidisciplinary approach that combines the four disciplines known as science, technology, engineering, and mathematics. This educational strategy highlights that it is no longer sufficient for modern citizens to understand science and mathematics; rather, their knowledge must be connected with technology and engineering. It also highlights the goals of legislative reforms, such as assuring ability in mathematics and science (Chesky & Wolfmeyer, 2015). STEM instruction uses a "learner-centered" methodology to help students improve their project management, cooperation, and self-direction skills (Stehle & Peter-Burton, 2019). According to Gomez and Albrecht (2013), it also fosters innovation by conceiving, planning, and implementing solutions to real-world issues and by using these issues as entry points for the incorporation of STEM disciplines (Margot & Kettler, 2019).

It is generally acknowledged that in order to solve the problems the world faces today, a new multidisciplinary scientific workforce will be needed. This workforce will need to be skilled in using new technology and interdisciplinary thinking, which may "require the integration of multiple STEM concepts'' (Roehrig, 2012). A diversified workforce that is STEM-literate and capable of understanding and

comprehending the technology environment must be trained and prepared; it is also commonly acknowledged (Merchant & Khanbilvardi, 2011).

In view of the above, this research aimed to explore teachers' perspectives on the benefits and role of STEM education in the solution of complex global challenges, with the objectives (a) to explore teachers' perceptions about the benefits of STEM education, (b) to discover teachers' opinions regarding the role of STEM education in the solution of complex global challenges, and (c) to compare teachers' gender-wise opinions about the benefits, and role of STEM education in the solution of complex global challenges.

LITERATURE REVIEW

The word "sustainable development" has been more and more prevalent in academic and scientific studies, on the platforms of the major political parties, and in all normative recommendations pertaining to public policy. Nowadays, the idea of sustainability has an implied value of responsibility at all human action levels, whether on a global, national, state, or local scale (Fernandez, 2011). According to UNESCO (2021), education is the first step in achieving sustainable development. With all of this in mind, we need to look at education and the classroom as a path to take if we want to build more sustainable societies that are capable of providing holistic solutions to existing problems, including challenges that are occurring around the world. Education for sustainable development is very necessary in our time (CONAMA, 2017).

The United Nations' "Transforming our World" 2030 Agenda for Sustainable Development set up 17 Sustainable Development Goals (SDGs) to deal with global problems like poverty, climate change, food shortages, and protecting the planet. The SDGs also aim to make sure that everyone has peace, prosperity, and a good quality of life (United Nations, 2015). The SDGs can only be achieved with the help of education, especially STEM (Science, Technology, Engineering, and Mathematics) education. SDG 2 (Zero Hunger); SDG 3 (Good Health and Well-Being); SDG 6 (Clean Water and Sanitation); SDG 7 (Affordable and Clean Energy); SDG 9 (Industry, Innovation and Infrastructure); SDG 12 (Responsible Consumption and Production); SDG 13 (Climate Action); SDG 14 (Life Below Water); and SDG 15 are among the specific global issues that STEM education aims to elaborate on and offer creative solutions to (Life on Land). Moreover, advancements in the STEM domains are crucial for achieving SDGs 8 (Decent Work and Economic Growth) and 11 (Sustainable Cities and Communities). The contribution of STEM to achieving the SDGs in the context of Industry 4.0 is essential (UNDP, 2019). The 2030 Sustainable Development Agenda has 17 goals to make the earth more sustainable by 2030. SDG 4, quality education for young generations and children, our future societies, is particularly important. The COVID-19 epidemic changed schooling. According to Bosch et al. (2011), young people need an integrated and multidisciplinary science education to understand global complicated food, energy, engineering, biology, environmental, illness, and epidemic problems.

Spector and Park (2012) reported some ill-structured problems (ISPs) that can be seen in every field of life including STEM subjects. These contain (i) designing a bridge to cross a certain body of water, (ii) figuring out the finest way to cure a patient with multiple chronic diseases, (iii) finding the faults in an electronic circuit that sometimes breaks, and (iv) coming up with an economic policy to solve a tenacious problem. Solving problems that aren't well-structured is a well-known example of a skill that is important in the twenty-first century. This is because the problems we face every day and the problems the world is facing now and will face in the future are often not well thought out. So, adding key skills for the 21st century, like learning how to deal with hard, unstructured problems and how to communicate, can help students in STEM fields deal with problems that have been around for a long time or are still coming up (Facer, 2012; Jamaludin & Hung, 2017). If we want to teach students of the 21st century the skills and abilities they need, we must give clear answers to questions about how many, how appropriate, and how important the challenges we give them are. In the sections that come after this one, there will be more talk about this subject.

According to Jonassen and Hung (2008), the complexity of an ill-structured problem can be determined by four things: (i) how much knowledge is needed to solve it, (ii) how hard the major concepts in the problem are, (iii) how complicated the steps to solve the problem are, and (iv) how complicated the relationships between the major concepts in the problem are. When all of these things are said about a problem's structure, it is said to be ill-structured (ISP). ISPs usually leave some room for doubt about ideas, rules, and principles that might be needed to come up with solutions (Jonassen, 2011; Shekoyan & Etkina, 2007; Voss, 2006). It makes sense that getting STEM students to work on ISPs is important since we all need to be able to solve problems in different ways in order to get through daily life. Many researchers think that being able to solve ISPs is a skill that should be taught to students in the 21st century (Facer, 2012; Jamaludin & Hung, 2017; King & Kitchener, 2004). To reach this goal, STEM teachers need to make sure that ill-structured problem-based learning is relevant, worthwhile, and possible. This is because a lack of relevance leads to a lack of motivation, which in turn leads to a lower level of learning (Saavedra & Opfer, 2012).

Education in the STEM fields aims to develop and give new solutions to ill-structured as well as global problems, particularly those that are directly relevant to the Sustainable Development Goals for 2030. STEM education addresses problems and explains numerous everyday situations. STEM education fosters problem-solving, self-improvement, and systematic thinking, which are essential today (Bybee, 2010; Roberts, 2012). STEM education helps students learn and employ problem-solving, creativity, research-questioning, critical thinking, entrepreneurship, and communication skills. STEM education improves students' problem-solving, innovation, critical thinking, technology literacy, and discovery (Choi & Hong, 2013; Morrison, 2006). STEM education is one of the best ways for kids to see the world holistically (Morrison, 2006). Single-subject knowledge rarely solves real-world challenges. Integrated STEM education has increased because students' school experiences should reflect this reality (Green, 2014). According to Teo (2019), the fundamental skills that need to be acquired today are referred to as the "4C skills," which stand for communication, cooperation, critical thinking, and creativity. These are the talents that make up the skills of the 21st century. It is the responsibility of educators to provide students with an education that can prepare them with the four critical competencies necessary to meet the challenges posed by globalization.

There has been a lot of interest shown by countries all over the world in STEM Education in recent eras. STEM education has become increasingly globalized: in the United Kingdom, Commonwealth nations such as Pakistan follow trends; in the United States, European and Asian countries appear to follow growth patterns; and in Australia, Australia appears to follow growth patterns (Hali et al., 2020) The STEM (science, technology, engineering, and mathematics) education system in Pakistan faces numerous challenges, the two biggest of which are the insufficiency of STEM educators' teaching skills and the inadequacy of student activities. Private schools prioritize STEM education more than public ones do. As a result, there aren't enough classrooms, labs, and other tools available for teaching STEM courses. Before there can be a rise in the number of STEM-based jobs, Pakistan's manufacturing industry has to experience more sustained development. Basically, Pakistan's system for instructing students in STEM subjects is underdeveloped and unfocused, and the government needs exclusive involvement to support the efforts of all stakeholders, including the general public and private players (Hali et al., 2021).

Previous research showed that STEM education has gained significant attention in the current era due to its potential to increase students' critical thinking, problem-solving, and innovative skills. According to the following studies, there are many benefits to STEM education. For example, Johnson et al. (2022) found that students engaged in STEM activities showed higher scores in mathematics and sciences courses, which proved that STEM education influences academic performance. Smith and Brown (2023) discovered that STEM education promotes the development of career goals aligned with the demands of the modern workforce. Chen et al. (2023) revealed that learners who engaged in STEM activities demonstrated improved skills in analyzing complex problems, creating innovative solutions, and making informed decisions. Martinez

et al. (2023) reported that students involved in STEM activities showed higher levels of self-confidence, teamwork, resilience, motivation, and enjoyment of learning. Li et al. (2023) found that STEM activities and projects stimulate students' creativity and increase their ability to think outside the box.

METHODOLOGY

This research was descriptive, in which the primary data were collected from the teachers working at the secondary schools in the Division of Faisalabad, Pakistan. All teachers working in government secondary schools were the population of this study. A sample of 100 teachers from four districts (Faisalabad, Toba Tak Singh, Jhang, & Chiniot) of Faisalabad was selected through a convenience sampling technique. There was equal representation of teachers from said districts. A closed-ended survey questionnaire with 13 statements based on a five-point Likert scale was developed for data collection. Before the application of the questionnaire, its validity and reliability were ensured. After data collection, it was analyzed through SPSS, and the frequency, percentage, mean score, and t-test were applied. The outcomes are presented in the below tables:

RESULTS AND DISCUSSION

Results reported in Table 1 show that all statements had mean scores higher than 3.50 and fall under the good agreement level. The overall mean score and standard deviation appeared as (M=3.92, SD= .955). Thus, these outcomes revealed that the majority of government secondary school teachers agreed at a high or very high level with all statements related to the benefits of STEM education. The findings of Johnson et al. (2022), Smith and Brown (2023), and Martinez et al. (2023) are also in line with the results of this study, as their studies also found that STEM education has many benefits, like improving students' performance, promoting the development of career goals aligned with the demands of the modern workforce, and improving students' self-confidence, teamwork, resilience, motivation, and enjoyment of learning.

Table 1. Teachers' responses toward the benefits of STEM education (N=100).

S. No.	Statements	M	SD	Level of agreement
1.	Education in STEM subject is crucial in current era	3.84	.884	High
2.	STEM education increase students' critical thinking skills	3.94	.930	High
3.	STEM education develops innovation and curiosity in students	4.21	.782	Very High
4.	STEM education improves students' cognitive skills	3.84	1.051	High
5.	STEM education develops students' problem-solving skills	4.03	.881	Very High
6.	STEM education makes students as responsible citizens	3.68	1.205	High
Overall Result		3.92	.955	High

The results stated in Table 2 show that all statements had mean scores higher than 3.50 and fall under the good agreement level. The overall mean score and standard deviation occurred as (M=4.00, SD=.789). Therefore, based on the said results, it was discovered that the majority of the government secondary school teachers agreed at a high or very high level with all statements related to the role of STEM education in the solution of complex global challenges. These results are in line with the study results by Chen et al. (2023), who also found that learners who engaged in STEM activities demonstrated improved skills to analyze complex problems, create innovative solutions, and make informed decisions. In addition, the results of Li et al. (2023), who found that STEM activities and projects stimulate students' creativity and increase their ability to think outside the box to solve complex challenges, are also consistent with the results of the present study.

Table 2. Teachers' perceptions towards the role of STEM education in the solution of complex global challenges (N=100).

S. No.	Statements	M	SD	Level of agreement
1.	STEM education is an interdisciplinary learning technique that helps students address real-world problems and boosts their interest in science.	3.75	1.095	High
2.	STEM education enables students to apply STEM knowledge to problem-solving, helping them acquire science and soft skills to tackle real-world challenges.	4.18	.948	Very High
3.	Education in the STEM fields gives students the power to eliminate pollution around the planet.	3.93	.868	High
4.	Students with a STEM education are better equipped to discover global sources of renewable energy and water.	4.11	.803	Very High
5.	Students with STEM education are better prepared to propose novel agricultural and food production techniques.	4.17	.682	Very High
6.	Students with STEM subjects are better prepared to deal with social and medical problems on a national and international scale.	3.83	1.129	High
7.	Students' skills in the STEM fields are better prepared to manage and find solutions to problems on a global scale.	4.04	,864	Very High
Overall Result		4.00	.789	High

Table 3. Gender-wise comparison regarding benefits and role of STEM education in solving complex Global Challenges.

Variables	Gender	N	Mean	Std. Deviation	t-value	p-value
Benefits	Male	50	3.90	.744	-.339	.735
	Female	50	3.94	.627		
Global Challenges	Male	50	3.89	.812	-1.111	.270
	Female	50	4.04	.552		

Table 3 shows the results of t-test statistics that were used to discover teachers' gender-wise differences regarding the benefits of STEM education and the role of STEM education in the solution of complex global challenges. Results showed that there was an insignificant difference between the teachers of both genders regarding the benefits of STEM education and the role of STEM education in the solution of complex global challenges. Therefore, it has been revealed that teachers of both genders were equally in agreement about the benefits of STEM education and the role of STEM education in the solution of complex global challenges.

CONCLUSIONS AND RECOMMENDATIONS

This study concluded that the majority of secondary school teachers agreed strongly with the benefits of STEM education. They agreed that STEM education increases the critical thinking skills of the students, develops innovation and curiosity in them, improves cognitive skills, develops problem-solving skills, and makes them responsible citizens. It was also revealed that most of the teachers agreed with the role of STEM education in the solution of global complex challenges such as STEM education develops students' understanding of real world problems, STEM education provides knowledge to tackle complex global challenges, STEM education enables students to eliminate pollution around the planet, STEM education equip students to discover sources of renewable energy and water, STEM education enable students to

propose novel agricultural and food production techniques, STEM education enable students to deal with social and medical problem at national and international level and STEM education prepare students to find solutions to problems on a global scale. Moreover, it has been revealed that teachers of both genders were equally in agreement about the benefits of STEM education and the role of STEM education in the solution of complex global challenges. The study recommends that a STEM educational approach be implemented from primary classes to higher education in order to equip students with STEM knowledge and skills to tackle complex global challenges.

The present research has some limitations, including small sample size, a narrow focus on only teachers of government secondary schools in a single area, and a narrow research approach. Therefore, extensive research may be conducted with the participation of teachers working at all levels, from primary schools to universities, as well as a comprehensive collection of quantitative and qualitative data with new variables.

The implications of this research are to enlighten stakeholders involved in secondary education and policymakers about the need to introduce a STEM education approach in order to develop secondary school students' understanding and skills in STEM subjects.

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