21st Century Skills Through STEAM Education: Analysis of School Leaders' Perspectives

Qaisar Abbas[1], Shafqat Hussain[2], Misbah Rehman[3], Shazia Tabassum[4] and Muhammad Mehdi[5]

Abstract

STEAM is an educational approach that strive for developing students' STEAM skills to meet the demands of the global workforce. This research examined the role of STEAM education in developing 21st century skills, and the factors influencing the integration of STEAM education in the Pakistani education system. It was a descriptive research. A sample of 100 school leaders, 52 male and 48 female, using a simple random method was selected. Researchers made questionnaire based on a five-point Likert scale was used for data collection after confirming its validity and reliability. The instrument's reliability ($\alpha = .87$) was calculated. The collected data were analyzed it using SPSS (version 26). This study revealed that the majority of the school leaders agreed about developing 21st century skills through STEAM education such as technology and information literacies, problem solving, critical thinking, leadership, social and civic literacy and responsibility. Most of the leaders also agreed regarding the factors influencing the integration of STEAM education in the Pakistani education system, such as lack of resources and infrastructure, ineffective teacher training, traditional teaching methods, cultural barriers, lack of awareness, lack of budget, traditional testing system, limited collaboration with industry, language barriers, and lack of clear guidance in policy and curriculum. Both Male and female leaders were agreed equally regarding 21st century skills and factors influencing integration of STEAM education. This study recommends that Ministry of Education should minimize the aforementioned factors in order to ensure the effective integration of STEAM education in Pakistani education system and in order to develop 21st century skills among students.

Keywords: 21st Century Skills, STEAM Education, Secondary School Leaders.

Introduction

STEM (Science, Technology, Engineering, and Mathematics) and STEAM (Science, Technology, Engineering, Arts, and Mathematics) education have received a lot of attention in the educational community in recent years. STEM education was initiated by the National Science Foundation USA in the 1990s to revitalize its development (Perales & Arostegui, 2021). Later, the STEAM method arose as a pedagogical alternative that combines science, technology, engineering, arts, and mathematics to create a more comprehensive and attractive education (Marin-Marin et al., 2021). The primary goal of incorporating the arts into STEM

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[1]*Principal, Al-Fajr College, Mari Indus, Mianwali, Pakistan. Email: drqaj@yahoo.com*

[2]*Director Operations, Haza Institute, Islamabad. Email: drhssn@yahoo.com*

[3]*PhD Scholar, Department of Education. The University of Faisalabad, Pakistan. Email: sibgharehman83@gmail.com*

[4]*PhD Scholar, Department of Education. The University of Faisalabad, Pakistan. Email: shaziatabasum369@gmail.com*

[5]*Lecturer, Al-Fajr College, Mari Indus, Mianwali. Email: muhammadmahdi1472@gmail.com*

education is to promote students' innovative thinking and imagination. However, both STEM and STEAM teaching approaches have demonstrated significant and favorable benefits on learners' creativity and problem-solving abilities at all levels of education (Aguilera & Ortiz-Revilla, 2021). Furthermore, Land (2013) emphasized the benefits of incorporating arts into STEM, claiming that standard STEM degrees focus on convergent abilities whereas art degrees focus on divergent talents. A STEAM method can help to overcome such a simplistic and disputable gap.

Tesconi and Aymerich (2020) define STEAM education as a means to develop scientific and technological abilities to acquire fundamental competencies and skills necessary to address global challenges. These challenges are captured in the 4Cs (Creativity, Communication, Critical Thinking, and Collaboration) and are referenced in the 2030 Agenda. In addition, Kim and Kim (2016) identified STEAM teaching skills, which include subject cognitive abilities, advanced thinking abilities, community-contributing abilities, and individual emotional abilities. These talents empower learners to exhibit creativity, problem-solving skills, critical thinking, effective decision-making, engaging communication for social interactions and collaboration, self-respect, positive emotions, consideration, and civil awareness. According to the World Economic Forum (2020), STEAM skills are crucial for the next workforce, as they anticipate the creation of 97 million new jobs worldwide by 2025.

The current advancements in information and communication technology is affecting every field of life including education. In many countries, individuals are struggling to be a leader in the scientific and technological race considering the importance of science and mathematics education (Cepni, 2017). Dincer (2014) says that people who are able to produce knowledge and apply the same whenever required are considered as the fundamental resource of any economy. Considering this reason, it is essential to educate and train the new generation with 21st century skills. The approach to obtain 21st century skills is through "STEM" in other words, science, technology, engineering, and mathematics. A trained workforce on the basis of STEM fields able to produce innovations that will provide an economic benefits to the nations as well as to be skilled in future business areas (Thomas, 2014).

Moreover, in the era of 21st century every country is striving to empower every learner with 21st century skills such as technological and information literacies, innovation and designing, collaboration and teamwork, problem solving, critical thinking, entrepreneurship, leadership, adaptability, social responsibility and ethics, civic literacy and responsibility and global and culture awareness that are essential to solve global complex challenges. Therefore, it is essential to produce a workforce required for future occupations, learners of 21st century must possess with 21st century skills in order to solve their daily problems as well as to tackle global complex issues (Sahin et al., 2014). The below figure is showing the 21st century skills adapted from (Alwis, 2018).

Figure 1: 21st Century Skills
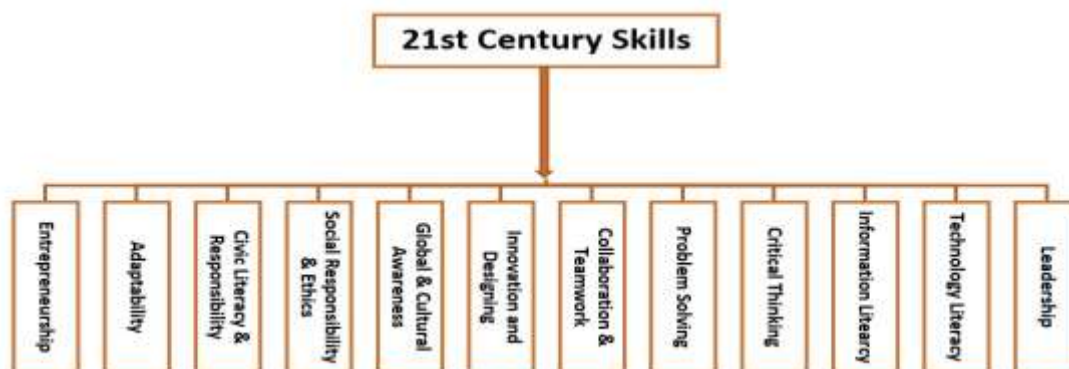
Recognizing the worldwide push and need for a STEM workforce, Pakistan has increased its emphasis on STEM education, including measures to incorporate arts into the curriculum to promote creativity and innovation alongside technical skills. The incorporation of arts into STEM education is considered a way to enhance transdisciplinary thinking and problem-solving abilities, equipping students for a rapidly changing global economy and technology landscape (Hali et al., 2021).

In Pakistan, the government has approved a STEM education initiative that would build STEM laboratories in government schools. In addition, the Ministry of Information Technology and Telecommunications (2020) has teamed with Google to start Pakistan's first grassroots-level Coding Skill Development Program, which aims to improve coding skills in students aged 9 to 14. Despite these attempts, several problems and reasons make it difficult to properly incorporate STEM or STEAM education into the Pakistani school system (Hali et al., 2021).

Based on the aforementioned information, this research aims to achieve the following objectives:

1) To explore school leaders' perspectives regarding the role of STEAM education in developing 21st Century Skills among students.
2) To investigate school leaders' views regarding the factors that influence the integration of STEAM education in the Pakistani education system.
3) To evaluate the significant difference among school leaders regarding role of STEAM education in developing 21st century skills and factors influencing the integration of STEAM in Pakistani education system.

Literature Review

The current research has extensive evidence supporting the urgent need for professional personnel with expertise in STEAM disciplines (Anisimova et al., 2020). However, the STEAM program has been promoted as a substitute for problem-solving and using creative and collaborative skills in learning environments to increase interest and engagement in mathematics, science, and the arts because of a shortage of competent workers in these sectors (Herro et al., 2017; Angel & Salgado, 2018).

STEAM efforts in education have grown in popularity over the previous decade, and they are now heavily integrated into modern curricula (Bush et al., 2020; Lin & Tsai 2021). These initiatives strengthen the curriculum's traditional aims while also encouraging innovation (Conradty et al., 2020). In the existing educational environment, where students create, study, experiment, analyze, manipulate, debate, discuss, and hypothesize, increases student motivation and self-efficacy (Conradty et al., 2020). According to Mengmeng et al. (2019), STEAM education is a key development driver with the capacity to transform the direction of education in this new interactive era (Tan et al., 2020).

According to Hali et al. (2021), the Pakistani government has also implemented STEAM education, recognizing its worldwide relevance. Several ways are being used progressively to integrate these disciplines into the normal educational system. In this sense, the government worked with universities and the Higher Education Commission to expand the concept of STEAM education across the educational system. According to Aslam et al. (2022), Pakistan is presently undergoing a new era of educational reform. The world is rapidly changing to accommodate learning in the twenty-first century, and as a result, educational quality must be enhanced and modified. Innovative education must be effectively applied in schools, integrating prior knowledge with learning development. STEM, while being an essential element of 21st-century education, is poorly recognized in Pakistan's K-12 and higher education institutions. Many initiatives in Pakistan have recently concentrated on STEM education.

In Pakistani education system, there are lot of challenges in implementing STEM education. In this regards the study of a study conducted by Aslam et al. (2022) identified, categorized, and reviewed empirical studies, the strength of the research base on STEM education, and gaps in the literature that require additional inquiry in STEM education at the K-12 and postsecondary levels in Pakistan from 2000 to 2020. According to this evaluation of 22 research papers, the most significant finding is that no systematic review of STEM education has been undertaken in Pakistan, and the topic is ignored. In the previous 20 years, STEM education research has diverged between scholars; no studies include STEM, STEAM, or comparable phrases in titles or keywords. Their research also revealed several notable findings, such as an apparent lack of awareness about STEM programs in Pakistan, which range from primary education to universities, indicating that more effort is needed in this area.

Research Methodology

The researchers adopted a descriptive research design for this study. Primary quantitative data were collected from school leaders in Shikarpur, a district of Sindh, Pakistan. The population comprised all leaders of government secondary schools in the district. The researchers selected a sample of 100 leaders, consisting of 52 male and 48 female, through a simple random sampling method. A closed-ended questionnaire based on a Likert scale with 20 items (12 item on 21st century skills and 8 items on factors), along with some demographic information, was developed by the authors and used for data collection. The validity and reliability of the questionnaire were ensured before its application. Prior to data collection, a consent letter was sent to participants to obtain their consent to participate in the study. After data collection, the data were analyzed using SPSS, where frequency, percentage, mean score, and t-test statistics were applied. The following results are occurred:

Results and Discussion

Table 1: School leaders' perspective towards role of STEAM education in developing 21st Century Skills among students.

Items	N	Minimum	Maximum	Mean	Std. Deviation
Q1. STEAM education increases technology literacy among students.	100	1.00	5.00	3.5500	.96792
Q2. STEAM education develop students' innovative and designing skills.	100	1.00	5.00	3.3600	1.06856
Q3. STEAM education improve collaboration and teamwork among students.	100	1.00	5.00	3.6800	.93073
Q4. STEAM education enhance students' problem solving skills.	100	1.00	5.00	3.6000	.95346
Q5. STEAM education develop students' critical thinking skills.	100	1.00	5.00	3.5900	.86568
Q6. STEAM education increases students' information literacy skills.	100	1.00	5.00	3.7100	.84441
Q7. STEAM education develop students' entrepreneurship skills.	100	1.00	5.00	3.6300	.78695
Q8. STEAM education creates students' leadership skills.	100	1.00	5.00	3.2900	1.07586
Q9. STEAM education increases students' adaptability to live in a multicultural society.	100	1.00	5.00	3.0600	1.17051
Q10. STEAM education develop students' social responsibility and ethics.	100	1.00	5.00	3.1900	1.04151
Q11. STEAM education increases students' global and culture awareness.	100	1.00	5.00	3.3600	1.13280
Q12. STEAM education increases students' civic literacy and responsibility	100	1.00	5.00	3.3300	1.07360

The results presented in table 1 show the descriptive statistics for each item included in the 21st-century skills indicator. Mean scores were used to evaluate school leaders' perspectives on each statement. All the statements achieved mean scores above than M=3.00, indicating a good level of agreement. Therefore, it can be concluded that the STEAM education approach may help develop 21st-century skills among students. These results are in line with the studies conducted by Sahin et al., (2014) and (Alwis, 2018). Sen et al., (2018) also reported that above skills can be developed through STEM education. This result is also supporting the results of this study. The findings reported by Hacioglu and Gulhan (2021) are also in line with current study' findings, as they discovered that STEM education enhance students' critical thinking skills.

Moreover, according to word cloud analysis technique, it is visible from figure 2 that word cloud image illustrates a collection of 21st-century skills and competencies that are essential for students in modern education, especially in STEAM fields. As the majority of school leaders agree, the STEAM approach can help enhance these skills for students. According to the word cloud, these skills include problem-solving, critical thinking, collaboration and teamwork, innovation, adaptability, technological literacy, information literacy, global awareness, civic responsibility, leadership, entrepreneurship, ethics, and social responsibility. These skills are known as '21st-century skills,' as indicated by the word 'century' in the word cloud image."

Figure 2: Word Cloud illustrating the 21st century skills

Table 2: School leaders' perspective towards Factors affecting Integration of STEAM Education in Pakistani education system

Items	N	Min.	Max.	Mean	Std. Deviation
Q1. Government attitudes towards quality education	100	1.00	5.00	3.4900	.98980
Q2. Lack of curriculum design and content in STEAM disciplines	100	1.00	5.00	3.7400	.79924
Q3. Lack of teacher training and professional development in STEAM fields	100	1.00	5.00	3.3200	1.03358
Q4. Un-availability of technology and equipment	100	1.00	5.00	3.5900	.93306
Q5. Lack of Funds to invest in STEAM education	100	1.00	5.00	3.4400	1.15750
Q6. Lack of quality governance and leadership	100	1.00	5.00	3.0500	1.08595
Q7. Lack of government initiatives and support	100	1.00	5.00	3.6900	.78746
Q8. Lack of alignment with national education policies and framework	100	1.00	5.00	3.6900	.76138

The results presented in table 2 display the descriptive statistics for each statement included in the indicator of factors affecting the integration of STEAM education in the Pakistani education system. Mean scores were used to evaluate school leaders' perspectives on each statement. All the statements attained mean scores above than M=3.00, demonstrating a good level of agreement. Therefore, it can be concluded that the above factors are creating obstacles in the integration of the STEAM education approach in the Pakistani education system. These results are in line with the studies of Angel & Salgado (2018) and Aslam et al., (2022).

Table 3: Gender-wise differences among school leaders regarding skills developed through STEAM education and factors influencing STEAM education.

Indicators	Gender	N	Mean	Std. Deviation	Std. Error Mean	p-values
21st century Skills	Male	52	3.4663	.39408	.05465	.593
	Female	48	3.4236	.40345	.05823	
factors	Male	52	3.4519	.40308	.05590	.235
	Female	48	3.5547	.45758	.06605	

The t-test statistics reported in table 3 show the mean scores, standard deviations, and p-values values for 21st-century skills and factors influencing STEAM education. The results indicate that 21st-century skills achieved equal mean scores for male and female leaders (p = .593>.05 levels), indicating no significant difference between the two groups. Similarly, factors influencing STEAM education also achieved equal mean scores (p =.234> .05 levels), demonstrating no significant difference between male and female leaders. Therefore, both male and female school leaders equally agree on the role of STEAM education in developing 21st-century skills and the factors influencing its integration.

Conclusion and Recommendations

This research has revealed that, according to school leaders' perspectives, the STEAM educational approach is highly effective in developing 21st-century skills among students. These skills include technological and information literacy, innovation and design, collaboration and teamwork, problem-solving, critical thinking, entrepreneurship, leadership, adaptability, social responsibility, ethics, civic literacy and responsibility, and global and cultural awareness, all essential for solving complex global challenges. Moreover, this study has also identified various factors that influence the integration of STEAM education into the Pakistani education system, such as the government's lack of commitment to quality education, inadequate curriculum design and content in STEAM disciplines, insufficient teacher training and professional development in STEAM fields, unavailability of technology and equipment, lack of funds to invest in STEAM education, poor governance and leadership, insufficient government initiatives and support, and lack of alignment with national education policies and frameworks. This study recommends that the Ministry of Education provide teacher training at all levels regarding the STEAM educational approach and address the factors influencing its integration to ensure the effective incorporation of STEAM education into the Pakistani education system and to develop the development of 21st-century skills among students.

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