PROSPECTS AND CHALLENGES OF IMPLEMENTING STEM EDUCATION: TEACHERS' PERSPECTIVES AT PRIMARY LEVEL

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Candidate of **Master of Philosophy** at the National University of Modern Languages do hereby declare that the thesis "**Prospects and Challenges of implementing STEM Education: Teachers' Perspectives at Primary level**" sumitted by me in partial fulfilment of Mphil degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in future, be submitted by me obtaining any other degree from this or any other university or institution.

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DEDICATION

I dedicate this thesis to my father Prof. Muhammad Jamil for his guidance, my husband Mudassar Jamil for his support and sleepless nights for me, my mother and my parents in law for their prayers and my supervisor Dr. Wajeeha Shahid who guided me with proper knowledge and appreciation.

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ABSTRACT

STEM education stands for a combination of Science, Technology, Engineering, and Mathematics Education. This educational discipline engages the students around the subjects of Science, Technology, Engineering, and Mathematics and emphasizes on integrated concepts of all these disciplines under one umberella of education. This research was carried out to find out the prospects of teaching through the STEM Education and the challenges faced by teachers while implementing this concept at primary level. An exploratory mixed method design was adopted. 214 teachers were selected through simple random sampling for the quantitative study and 50 teachers were selected by purposive sampling for the qualitative study comprising of population of 1000 teachers. A survey of 32 items of 5 points lickert scale was filled by 214 teachers and 50 teachers were taken for the focus group discussion which were divided into 10 groups each containing 5 teachers. The collected data was analyzed by using the SPSS software. Word cloud was used for focus group and descriptive statistics were used for analysis of questionnaires. The findings of the study revealed that it was difficult for primary level teachers to implement STEM Education in schools. The findings for the qualitative part indicate that while teachers value STEM Education, they reported barriers such as pedagogical, curriculum, structural challenges, concerns about students and assessments, and lack of teacher support. Implications suggest that the teachers who get proper training and guidance and support from the institutional management are able to adopt STEM Education in the classrooms rather than those who are lacking training and institutional support.

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CHAPTER 1

1.1. INTRODUCTION

In 13th Century the new method of education was formally created. The aim of the modern education system is to raise individuals who search for ways to reach information, know where and how to use the information they have learned and have critical thinking (Elmira et al., 2022). The growing educational world is exploring the approaches to provide students with some good skills and knowledge that they would need in the 21st century workforce to be successful innovators. Continuous efforts are being made to explore and develop innovative methods and tools that can effectively enhance student interest and elevate the learning experience (Sırakaya & Alsancak Sırakaya, 2020). Teachers have an important role which is facilitator to help students meet their needs and learning success (Suebsing & Nuangchalerm, 2021). Nowadays, as in schools it has become the basis of the modern educational structure and is still followed. Formerly, the schools used to focus on concept focused curriculum but recently then are focusing on promoting a structure of lifelong learning.

In recent times the hard sciences club has received much importance in creating a new educational branch called as STEM. The issue of science, technology, engineering, and mathematics (STEM) education has developed very rapidly in all countries. The issue of science, technology, engineering, and mathematics (STEM) education has developed very rapidly in all countries. The comprehensive integration of the four disciplines provides great potential to improve the quality of learning (Farwati et al., 2021).

The acronym STEM (Science, Technology, Engineering, and Mathematics) has gained significant importance worldwide, serving as a catalyst for policy advocacy across various domains. It encompasses industry and research, higher education participation, and school curricula. The underlying concept suggests that these four disciplines form a comprehensive package of subjects, encompassing knowledge and skills related to the sciences, applied sciences, and the digital world. This integrated approach is crucial in shaping a post-industrial global future and plays a vital role in determining the future prosperity of nations (Tytler, 2020). Worldwide, with the development of the global economy, science and technology STEM education has become an important approach and policy for the beginning of the scientific and technological abilities and the modification in education and teaching (Gao et al., 2020). The needs of society have been changing and new professions are emerging in response to advancements of technology and science. In recent years, economic development has become closely associated with the availability of personnel qualified to work in the fields of science, technology, engineering and mathematics (STEM), because STEM careers are necessary for countries' economic growth and global competitiveness (Çiftçi et al., 2020).

There is an educational discipline which engages the students around the subjects of Science, Technology, Engineering, the Arts and Math and emphasizes on steam education. Now a days using STEM education the students learn to establish with math, although they make researches as scientist and historians using different technologies which helps them in understanding the worldwide development and communicate about their needs so that they can obtain universal sustainability. In a broad context, STEM education can be viewed either as the

collective combination of individual disciplines within STEM or as an interdisciplinary approach that emphasizes the interconnectedness across these disciplines (Gao et al., 2020).

Among the outcomes offered by STEM education at primary level are increasing school readiness and school success of children enabling them to learn how to develop different products creating a basis for lifelong learning and facilitating their socialization enabling children to think deeply, be curious and form an interaction with the world they live in. In line with all these outcomes, it can be said that the implementation of STEM education at primary level will have many positive contributions. For this reason, it is necessary to support primary level educators in implementing STEM education and to contribute to their professional development (Çiftçi et al., 2020).

1.1.1. Concept of STEM Education

The contraction STEM was introduces in 2001 and was created up by the initial letters of Science, Technology, Engineering and Mathematics. Initially it was introduced as SMET (Science, Mathematics, Engineering and Technology) which could cause issues of offensiveness (Breiner et al., 2012). STEM education have a very refined and exclusive prospectus to temper the students' interest in STEM subjects. STEM stands for science, technology, engineering, and math. These four cyphers characterize the various areas of STEM education. This new methodology is now being used in school systems as well. As a philosophy, STEM is meant to create a program that integrates all four disciplines in a way that forces the student to use cross-disciplinary knowledge to solve problems. As a philosophy, STEM is meant to create a program that integrates all four

disciplines in a way that forces the student to use cross-disciplinary knowledge to solve problems (*What Is STEM?*, 2020).

Some years ago the word STEM was not known in the field of education and was also not heard commonly except from that with the advancement in the technology. According to the recent studies and reports approximately 65% of the primary school children will at the end finish up working in entirely new job types which do not exist in the reality. Whereas, this field is forever lively, it offers students the chance to transform and encounter their knowledge. Herbart played a significant role in recognizing the importance of education in shaping the character and values of students. He emphasized that the ultimate objective of education is to foster the development of individuals who possess strong character and humane convictions. According to Herbart, education should empower students to comprehend the profound art of constructive and harmonious living. Herbart also precisely referenced interdisciplinary studies by saying: “geography, mathematics, the natural sciences and history are combined” (Glancy et al., 2013). This facilitated and provided the source for the improvement of Science, Technology, and Society/Studies (STS) movement. STEM is a politically decent move, rationally, math and science would rather not take on innovation and neither does innovation need to embrace math and science. There are traps and open doors with these choices. We are moving towards designing training and STEM as opposed to turning out to be important for science.

In STEM Education, it is somewhat diverse from outdated education that essences on math and science. In this students are amalgamated in a situation that smears the scientific method that is appropriate in daily life. The students learn by doing and are stimulated to improve new identifications while filtering

their concepts. As an alternative of preparing students in any one of these domains, STEM coordinates each of the four in an interdisciplinary and useful strategy, in order to all the more likely get ready understudies to have a profession and taking into account true applications.

It has been discovered from past researches that in determining the quality and effectiveness of the integrated STEM education teachers play an important role (Khairani, 2017). Hence, it is important to scrutinize the attitudes of the teachers towards integrated STEM education so that it should be ensured that national level of educational reform can be achieved and its objectives could be achieved. It is not necessary to involve all four disciplines of STEM in integrated STEM education in the same class. According to M. Stohlmann integrated STEM education is actually a struggle in which STEM disciplines can be combined in one class, but it should be noted that it involves multiple classes and there's no need to involve all of the four STEM disciplines (Shernoff et al., 2017). M. Sanders has provided a concise definition of integrated STEM education, describing it as educational approaches that involve the exploration of teaching and learning connections between two or more STEM subject areas, as well as between a STEM subject and other school subjects. This inclusive approach encourages interdisciplinary learning and promotes the integration of STEM concepts across various academic disciplines.

1.1.2. STEM Education at different levels

At elementary level of schools mostly students are introduced to the ordinary organization of the subjects or curriculum. There's a connection built with all four subjects of STEM i.e. Science, Technology, Engineering, and

Mathematics. The primary reason and objective to be achieved at this level is to motivate and inspire the curiosity of students who desires to move on in the courses in their respective fields.

At middle school level students are introduced to the academic requirements of the respective field. Students are given an intuition into STEM careers. There are some challenges that a teacher has to face while implementing the STEM education in the curriculum. The challenges could be pedagogical challenges, curricular challenges, structural challenges, student concerns, assessment concerns, and teacher supports. Teachers senses that it could be possible to implement the STEM education in the curriculum through collaboration and by using a quality curriculum, having schools provision, using prior experiences and by certified development.

1.2. RATIONALE OF THE STUDY

The present research is adopted to study the prospects and challenges of implementing STEM education at primary level. As the majority of the areas are reliant upon the STEM fields, it in a roundabout way assumes a huge part in the thriving of the economy. Students and teachers must work together so that subjects are presented and understood in a manner that can be practiced in real-life in an integrated manner. Teaching students in STEM subjects prepares them for a life long learning. This will provide a base to move towards higher levels of education with a trained mindset in all disciplines in an integrated manner. In order to effectively implement STEM education, teachers must possess a deep understanding of how to align curricular standards, create integrated assessments, and develop lessons that ensure both the arts and STEM areas are

taught with integrity. It is crucial for teachers to employ specific strategies that cater to the needs of their students. To gain insight into the adoption of teaching methods for STEM education, it is important to explore the perspectives of primary school teachers. Teaching any area of STEM allows teachers to introduce their class to the basic principles of technology and provides them with an outlet that allows the children to build technological literacy at their own pace. While students engaged in STEM projects may benefit from experiential learning opportunities, it is essential to recognize that STEM education should extend beyond the confines of science, innovation, design, and mathematics. STEM encourages active learning and gives students a sense of ownership over the teaching-learning process both inside and beyond the classroom. Our economy demands more than just a basic comprehension of these areas; it requires the application of knowledge, creative problem-solving, and resourcefulness. Application of STEM Education is possible only if the teachers reflect a positive attitude, towards its adoption at grass root level i.e.; at primary level of schooling / teaching. Teaching any area of STEM allows teachers to introduce their class to the basic principles of STEM and provides them with an outlet that allows the children to build literacy at their own pace.

1.3. STATEMENT OF THE PROBLEM

The problem under investigation states that as STEM Education is introduced at college and university level and instead of teaching a single subject students are taught in the integrated way through which their learning and academic behaviors can be made better. There is need of integrated curriculum in STEM Education at primary level also. As primary level students are at the stage when they are becoming creative absorbent and curious learners is if

students at this stage are taught with proper integrated curriculum they will pursue towards multidisciplinary or interdisciplinary education for their future studies. STEM Education is an integrated concept so its adoption can only be possible if the primary level teachers understand the opportunities and challenges related to this concept. For this purpose, it is imperative to explore primary school teachers perspectives and to guide them to convert the challenges involved into opportunities.

1.4. RESEARCH OBJECTIVES

The following will be the objectives of this study:

i. To examine the perceptions of primary school teachers about STEM Education.

ii. To explore the challenges which are faced by teachers while implementing STEM education at primary level.

1.5. RESEARCH QUESTIONS

The following will be the research questions of this study:

i. What are the prospects in implementing STEM Education at primary school level?

ii. What are the challenges faced by primary level teachers while implementing STEM Education?

1.6. SIGNIFICANCE OF THE STUDY

This study will be significant and worth consideration for primary school level teachers, students, stakeholders, and policy makers. This study will be critical for primary instructors as they will go about as an information medium

between the student and the ideas being educated. They will cover all the essential material in the classroom while countering all the challenges. They will direct at whatever point the students are uncertain of how to continue with an issue or a task. The results of this study can be significant for students as they will get the chance to study different subjects in integrated way. Students will have a sense of curiosity that constantly looks for activities that can challenge them. This study will be worth consideration for policy makers as they can study and indulge the principles of STEM education in curriculum. This study will be significant for stakeholders, when the results of this study will be implemented in the curriculum designed then it will assists the students learning and will then think for their future career.

1.7. DELIMITATION

i. The study was delimited to 50 teachers for focus group and 214 teachers for questionnaires.

ii. There are approximately 200 private schools in Lahore which are implementing STEM Education.

iii. It was impossible to collect the data from so many teachers in short time.

1.8. THEORETICAL FRAMEWORK

Vygotsky's social improvement hypothesis tends to a few thoughts that whenever applied to Science, Technology, Engineering and Mathematics (STEM) training, a bigger number of students are bound to seek after college degrees and vocations in STEM a while later. Generally, students presentation in STEM subjects and their acknowledgment is unequivocally connected with how charming

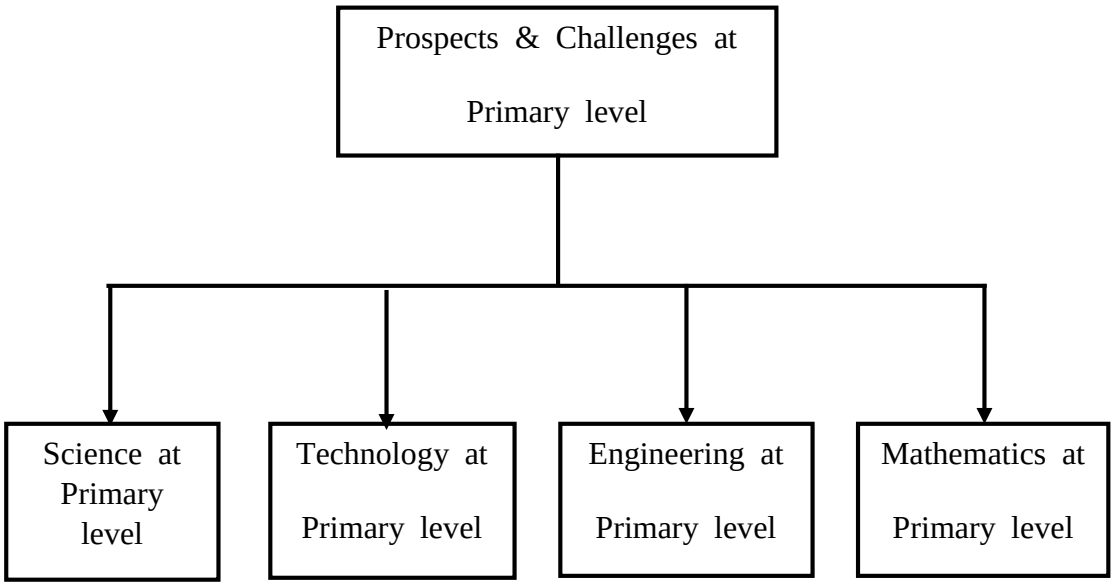
and remunerating their opportunities for growth were the point at which they were first acquainted with them. Vygotsky's theory introduces and utilizes pedagogical concepts such as Constructivism, the More Knowledgeable Other, and the Zone of Proximal Development. When these are appropriately applied in STEM classes it may result in fostering a positive learning experience and enabling students to develop a genuine passion for STEM education.

Constructivism is an approach which enables learners to construct their knowledge on their own. In STEM Education there is same that students socially cooperate in numerous ways as the learning occurs in gatherings and not in disengagement. They effectively coordinate to take care of issues, research, examine, discussion and even make their own special inclining encounters. The teacher or mentor are the one who mentors the students until they reach their learning goals.

The ZPD is the zone between what the learner knows or can learn on his or her own and the zone where the learner cannot learn even with the help of the teacher. Same as in stem education some opportunities are given to the students through which they explore their own knowledge and ideas and then apply it scientifically. Vygotsky emphasized the role of society in learning. As indicated by him, there should be communication with the general public and climate for figuring out how to occur. Society is what motivates and what gives meaning for learning. In reflection to what has been introduced from Vygotsky’s theory, no other subjects can benefit from these practices as STEM subjects. For one basic explanation, these subjects are worried about unmistakable issues that are noticed and experienced everyday in our actual world. In STEM Education

students solves a real world problem in which they have interest in classroom rather than the teacher solves many problems from a text book that is not of their interest. So in STEM Education the students learn by doing themselves same as the theory of Vygotsky (Hamza, 2019).

1.9. CONCEPTUAL FRAMEWORK



(Nikitina & Ishchenko, 2022)

The conceptual framework of the study shows that the prospects of adopting STEM from teachers' perspectives and the potential challenge will be explored. Same as the challenges faced by teachers while implementing science, technology, engineering and mathematics will be explored. Furthermore the findings may suggest a way forward.

1.10. OPERATIONAL DEFINITIONS

1.10.1. Science

The knowledge about the existing world, making observations about the natural and physical environment and doing experiment on it, is known as science. It also tells about the truths and laws of the world. It also tell about the reality of the world.

1.10.2. Technology

Any instrument used to fulfil the human needs such as to communicate or to process data faster is technology. Tools used to enhance teaching and learning is also technology. Application of scientific knowledge is also known as technology. This also includes diverse subjects, such as contemporary arts, applied science, and natural science.

1.10.3. Engineering

Engineering is the branch of science and technology. It uses scientific values for the usage of human being. It connects the disciplines such as to seek the problem and then by scientifically solve that problem. It is used in the development of building, mines, transport making, motors and synthetic plants.

1.10.4. Mathematics

Mathematics is the summary of numbers quantity and space. It helps in logical thinking and build critical thinkers. It is also applied in grading, scoring, measuring and disciplines like physics and engineering. It incorporates variable based math, analytics, and calculation.

CHAPTER 2

LITERATURE REVIEW

Socrates and Aristotle are accredited with the perception that the "quest of knowledge is the utmost good" and that this is the basis of education (Glancy et al., 2013). In modern research universities this concept is still used as the foundational concept. Education in Pakistan is really a matter of concern. Inadequate government policies, lack of budgets, lack of implementation of policies and educational infrastructure are the key reasons behind the decline in quality education. Quality education plays a fundamental role in the professional development of a nation, contributing significantly to its overall progress and global competitiveness. It serves as a cornerstone for individual growth, societal advancement, and economic prosperity (Budiharso & Tarman, 2020). Although many of Non-governmental institutions including international organization have been raising their concerns regarding poor quality of education and educational infrastructures including the curriculum used in primary and secondary education but the response and steps taken by government are not enough. The quality of education is intrinsically linked to employability rates and the attainment of favorable outcomes. When education is of high quality, it equips individuals with the necessary skills, knowledge, and competencies to succeed in the job market and contribute meaningfully to society (Budiharso & Tarman, 2020). 46% literacy rate reflects the backwardness in education standard perspectives (Awan et al., 2017).

In the evolving landscape of education, there is a growing emphasis on adopting multidisciplinary studies to bring forth outcomes that are benifitial and have capacity to enhance thinking and acting capabilities. Among these interdisciplinary approaches, STEM (Science, Technology, Engineering, Mathematics) education stands at the forefront (Mustafa, 2018). STEM acronym and idea in education was proposed by US scientist at US National Science Foundation in 2001 with the prospects of modernization of education techniques of contemporary engineers and researchers in universities. Descartes, an epistemologist and the first major philosopher made many significant statements that gives forte to the expansion of the STEM movement. Earlier in 17th century his concept was introduced which included that the goal of education should be to examine all things which includes misrepresentations, to know their value (Glancy et al., 2013). STEM has emerged as a critical global policy, and there is a compelling need for prioritizing it and its associated fields (Tytler, 2020). STEM means Science, Technology, Engineering, Mathematics, that it is a discipline based on education and teaching of design-centered knowledge including skills of these areas although it is relevantly a new educational approach its implementation is challenging but its importance is growing and it is evolving in current education at great pace. (Mustafa, 2018). In Pakistan STEM as career initiative was taken by Higher Education Commission in partnership with Pakistan Institute of Engineering and Applied Science (PIEAS). The motto was enabling youth and children to pursue career oriented education in the field of science, technology, engineering, mathematics. STEM education help individuals to understand their potentials, thoughts and practicability of their knowledge, its linking's, relations with different events, scenario's and behaviors and through

this they could develop their own response, ideas for the betterment of the society. STEM education have become very crucial in various aspects such as driving industrialization, capitalizing on global market potential, gaining economic advantages, and nurturing highly skilled individuals who contribute to present and future business landscapes. Therefore, prioritizing STEM education becomes essential, the focus on STEM education helps encompassing the development of STEM literate students from early childhood to higher education and subsequently employing them based on their individual aptitudes in industrial and technological sectors and this way economy as a whole may achieve industrial and economic advancement of nations (Mustafa, 2018).

Rousseau assisted in founding the recognized partitions of science and their inter-connectedness in realism and in education. STEM education has garnered increased attention and research; however, it remains a subject of ongoing debates and dilemmas. There is limited consensus on its precise definition and the most effective ways to implement it in practice (Gao et al., 2020). However, it would be an oversimplification to perceive STEM education solely as the teaching of science, technology, engineering, and mathematics. In reality, STEM education represents an integrated, interdisciplinary, and practical approach that combines these four subjects into a cohesive learning framework. It goes beyond theoretical concepts and incorporates real-world applications and instructional methods, ensuring that students across various disciplines can benefit from its principles. Recognizing the power and effectiveness of this educational philosophy, some educators and organizations expand the acronym to STEAM, incorporating arts and other creative subjects into the mix (UTEP Connect, 2021). STEM generally referred as curriculum in science, technology, engineering, and

math. However, in wider prospects it’s a base for an education with realistic, extensive, transparent, and other features. Using this methodology students are guided to explore opportunities and understand the world around them and develop ability to turn their scattered knowledge into a unified thinking that is interconnected.

It is an interdisciplinary learning method that is not limited to comprehensive solution to practical problems or teach separate knowledge of each subject as observed in case of traditional teaching. STEM education has a clear objective: to integrate the disciplines of science and mathematics, which provide the foundation of scientific knowledge, with technology and engineering, which serve as their practical application fields. This integration aims to enhance students' problem-solving skills by adopting a comprehensive and optimistic perspective. Furthermore, STEM education nurtures students' creativity, empowering them to explore innovative approaches and ultimately create tangible products (Mustafa, 2018). It develop skills and help in building ideas through interlinking knowledge and experiences. Many researches and studies have revealed that one of the fundamental problem in today’s school is that they take STEM Education different from traditional education (D.C.D., 2016). As a result most of the students fails to correlate their prior knowledge and the new experience or skills in realities. The moral teaching and learning methods may lead to memorization of factual information (Park, 2016). The students usually fail to elicit comprehension of meaningful learning (Mohd et al., 2017). Usually students found difficulties in applying cohesive knowledge learnt in separated class room while solving complex problem. To be successful against 21st Century

global challenges student needs quality and effective STEM Education (B.M, 2016).

Solid foundation in science, technology, engineering and mathematics is possible through STEM education. Accordingly, educationists and researchers are trying to find ways to improve the quality of STEM education so that the goal of increasing students' interest and achievement in STEM fields could be achieved. Only the trained educationists that have required skills and knowledge can ensure that students can get the knowledge and can acquire aforementioned STEM gains. Educators and researchers still seek to solve that how STEM education should really be. The information, abilities and convictions in STEM schooling are cooperatively built at the convergence of more than one STEM branches of knowledge (Estapa & Tank, 2017).

2.1. STEM CONCEPT IN PUBLIC VS. PRIVATE AT PRIVATE LEVEL

Pakistan's Ministry for Planning, Development & Reform conducted a seminar in which it was judged that despite increasing salaries of the teachers the struggle to improve teaching and putting effort to quality education to showcase their actual potential and science-based competencies has been decreased (CIS, 2020). Further that it was realized that regardless of increasing salaries, significant improvement in the public school sector can be achieved through hiring of new innovative and energetic educationist that could bring reforms and improve the methodology of teaching education with contemporary academic knowledge. Government is also focusing that STEM education have taken steps to collaborate with different universities researchers and higher education teams

to improvised STEM education in Pakistan in order to develop technological and innovative curriculum (Chahudary, 2019).

Different reforms oriented movement and societies with support of government are trying to facilitate education system (Iteach, 2020). This movement aims to teach low-income schools that lack quality education through recruiting and training top graduates from young professionals. One other organization with name STEM Vision is actively working with an aim of educating and re-educating girls and providing free STEM education to underprivileged Kids in Pakistan. STEM Education has received much attention all over the world. It is considered that the best method to compete in globalization is to achieve STEM education. Most of developed countries are designing their pattern of STEM education but most of common wealth countries including Pakistan adopt UK based STEM education pattern. In developed and emerging countries an increasing field is the convergence of science, technology, engineering, and mathematics, known as STEM education (UNESCO, 2020).

When we study the implementation of STEM education in real life around us we will find that each private school takes its unique approach. Some schools make STEM their central focus, while other adopting multidisciplinary approaches and making it more comprehensive strategy by integrating STEM elements across various classes, programs, and activities and cascading this behavior throughout their education system. Additionally, there are many schools/educators that have establish specialized facilities like the STEAM Factory, an incubator and accelerator that encourages students to explore their inventiveness, creativity, and design skills. At St. John's-Ravenscourt School in Winnipeg, STEM education begins as early as kindergarten, where young students are introduced to tablets

and computers in order to develop their skill and knowledge regarding positive use of technology to enhance mental productivity i.e. skills to design and develop ideas and capabilities of problem solving. This educational emphasis continues throughout high school, offering a wide range of STEM courses for students to choose from based on their interests. Technology is not only integrated into every aspect of the curriculum, classrooms, and lessons but also expected to be utilized by students for learning and communication purposes. The school strives to create a technology-enriched learning environment that fosters critical and creative thinking, social responsibility, and lifelong learning.

Many private schools also incorporate STEM into their extracurricular activities, organizations, and field trips at primary level. Some schools organize science fairs, math competitions, and after-school clubs where students can refine their coding, design, or robotics skills alongside peers who share similar interests in specific STEM disciplines. The anticipation for the reinstatement of after-school activities programs is high, as they provide students with opportunities to apply and expand their knowledge of STEM subjects within a community context through internships and club participation (How Private Schools Are Prioritizing STEM, 2022).

2.2. STEM DEFINITION AT PRIMARY LEVEL

The word STEM includes four words; Science, Technology, Engineering, and Mathematics these subjects have nearly been essential for each student educational plan especially science and math. These are characterized as:

2.2.1. Science. Science is methodical investigation of nature and ways of behaving of material and actual universe, that depends on perceptions, tests, and

estimations, and the plan of regulations to depict these realities for the most part (Science, 2012).

2.2.2. Technology. Knowledge-based examinations encompass the study of specialized tools, their development, and their intricate connections with the world, society, and the environment. This field draws upon diverse subjects, including design, contemporary arts, applied science, and natural science. These examinations focus on understanding the advancements and applications in technology, considering their impact on various aspects of our lives, and promoting an interdisciplinary approach to problem-solving and innovation (Technology, 2012).

2.2.3. Engineering. Engineering is a craftsmanship or study of applying essentially the information of natural sciences, as chemistry or physical science, as in the development of building, mines, transport making, motors and synthetic plants (Engineering, 2012).

2.2.4. Mathematics. Math is a gathering of related sciences that incorporates variable based math, analytics, and calculation and is worried about examining the numeric, amounts, space and shapes and the connections between them by utilizing a particular documentation (Mathematics, 2012).

2.3. SCIENCE EDUCATION AT PRIMARY LEVEL

In the 19th century, science or science-related subjects were incorporated into school curriculum primarily to equip students with a foundational knowledge with a purpose that whether or not to pursue further studies in science at the university level and mostly the subject was in form of theoretical knowledge instead of practical applications (Fensham, 2008). However, in contemporary times, particularly following the Education for All conference (UNESCO, 1990), there

is a widespread acknowledgment that science education in schools at primary level serves a much broader purpose. Expert in science education has agreed to the fact that field of science education has broader the vision and applicability that has added insight to other disciplines and same fact and thoughts about contribution of SE in different fields has been accepted by experts in other fields (Yakman, 2018). It helps students to be productive member of society through transfer their Knowledge with an ability to apply scientific thoughts in novel situations. Science Education is not limited to finding facts and understanding science but also develop ability to practically apply it in new situations. The Greek culture didn't have an understanding of this concept and therefore it kept them from developing experimental science. Although analysis is vital area in science but without experimental science it would become dull or less effective.

The inclusion of science education in primary schools is now recognized as a means to promote scientific literacy. Alongside this, communication skills are also acknowledged as a vital aspect of literacy, encompassing its core definition rather than being considered a secondary aspect (Norris & Phillips, 2003). Scientific thought comprises of inductive and deductive thought, processes and attitudes (Yakman, 2018). Therefore, for students to understand science, these levels of thoughts, processes and attitudes are needed to be formal part in science education. Three interpretation are dominant of teaching science, first known as structured bodies of knowledge which are rich in its content, second is set of investigative processes and the third one is interconnection of human activity with application of technology. And this third process is actually related to generation of hypothesis. Science education presents a significant challenge, as it requires striking a delicate balance between meeting the needs of the minority

who will pursue advanced studies in science and addressing the needs of the majority who will not (Osborne, 2007). This balance involves designing educational approaches that provide sufficient depth and rigor for aspiring scientists, while also offering meaningful and engaging science learning experiences for the broader student population. By navigating this challenge, science education can inspire curiosity, critical thinking, and scientific literacy among all students, regardless of their future career paths.

2.4. TECHNOLOGY EDUCATION AT PRIMARY LEVEL

The term "technology" encompasses the application of scientific knowledge to artistic endeavors. Over the past few years, the concept of technology has evolved. In the context of education, the term "educational technology" combines the fields of education and technology, where the principles of learning and communication are applied to teaching practices. It can be defined as the systematic application of scientific knowledge to practical tasks in the field of education (Venpakal, n.d.).

In a traditional school setting, technology plays a crucial role in enhancing the efficiency and effectiveness of education by facilitating the acquisition of knowledge and skills. When technology is directly integrated into an educational environment, such as a school, both students and teachers are seen as learners. Therefore, it can be assumed that any increase in teacher knowledge and utilization of technology results in improved learning outcomes for students. Ultimately, the purpose of technology in primary schools is to enhance student achievement (Driscoll, 2017). In today's world, technology holds immense importance and influences various aspects of our lives. One significant area

where technology's presence is particularly pronounced is in the field of education. Technological advancements have led to the proliferation of education among people, and continuous research and development are being conducted to introduce advanced technologies that make education more accessible, enjoyable, and easier to engage with. With the aid of technology, education for children has become more interesting and user-friendly, eliminating the traditional perception of education as a tedious and burdensome process (Free Research Journals | Publish Research Paper India | Best Engineering Journals | Research Paper Publication Site : IJEAST, n.d).

Technology education has been considered as K-12 venue for cross-curricular studies and its relationship with science has been mutually involved since the beginning of both fields. “Scientific advances are technological advances” because they mutually leads to the production and invention of new technologies and “advances in the uses of tools are needed in order to improve and test inferences in science” (Yakman, 2018). It is often said that science is the base framework on which all technologies are based and functioning. Even though science is base for technology and that both are independent disciplines with separate goals, methods and outcomes. Malay plan offered primary means for applying principles of science and mathematics whereby science is portrayed as reality and mathematic the tool in such a manner that student centered activities are focused on testing, analysis, materials, investigations and process. It seems logical to say that to learn technology is impossible while excluding the study of science, how helpful engineering process is to create and mathematical calculations to design it up and understand the effects of it (Yakman, 2018).

Technology plays a pivotal role in enhancing educational achievement through two primary approaches: eliminating physical barriers to learning and shifting the focus from knowledge retention to its practical application. To fully grasp their value and impact in educational settings, it is essential to consider how these approaches relate to both students and instructors. Moreover, internet-based technology enables teachers to establish their own learning communities that extend beyond the limitations of local school sites. For instance, science teachers can utilize wikis or content delivery systems to connect and exchange information with educators from other schools within and outside their immediate school district (Driscoll, 2017). Distance education, facilitated by technology, has become an invaluable resource for students who were previously unable to pursue their degrees due to geographical constraints. Thanks to the rapid advancements in technology, distance is no longer a barrier, opening up new opportunities for remote learning (Free Research Journals | Publish Research Paper India | Best Engineering Journals | Research Paper Publication Site : IJEAST, n.d).

However forward thinker contended that it’s not enough to understand element of technological works and effects the tangible objects, but also it is important to understand development of technologies through societal demand how it is important to initiate a knowledgeable citizenry considering economic, social and visual values. Some educationist not focused specifically the content but on the way the curriculum is offered that involved any and all subjects encountered naturally in the investigative instruction process. Despite having different contents, methods and strategic aims by various people in technology education, all were of the view that ultimate goal of leader is creating functionally

and technically literate people that are well suited with rapid changes in technology and society.

Nevertheless, technology has the ability to assist students in visualizing previously unfamiliar content, thereby enhancing the learning process. One effective approach is the use of multimedia presentations, which combine various media formats such as images, narration, and text to aid students in conceptual understanding. Additionally, simulations and games introduce an interactive element that transforms education from a passive experience to an active one. Advocates of multimedia learning follow a cognitive learning philosophy and highlight the key advantage of utilizing multiple sensory channels, recognizing that each channel can only process a limited amount of information at a given time (Driscoll, 2017). The influence of technology on education has far-reaching implications for the future. With the development of searchable databases, now accessible even on handheld devices from remote locations, the definition of learning objectives is being reshaped. There is a notable shift from mere memorization and recitation of facts to the utilization and development of skills that enable improved research and evaluation of alternative sources, such as online databases (Driscoll, 2017).

2.5. ENGINEERING EDUCATION AT PRIMARY LEVEL

Due to development in science and technology, new fields emerge together, as engineering, which has its own place in science category. Engineering can be defined as a discipline that combines creativity and logical thinking, rooted in mathematics and science, and employing technology as a bridging tool to make meaningful contributions to the world. Engineers leverage their innovative and

problem-solving skills to design, develop, and implement solutions that address complex challenges across various fields. By integrating their knowledge of math, science, and technology, engineers play a crucial role in shaping the world around us and making significant advancements in diverse domains (Yakman, 2018). Engineering education encompasses the process of imparting knowledge and principles relevant to the professional practice of engineering (Douglas, et al., 2012). In engineering we used creativity and logic that is based on science and mathematics, the utilization of technology to create contribution as linking agent in the world. Study about designs and technology by students is actually studying engineering. It is not linked to historical k-12 structure and has its own discipline. Engineering education cannot be fitted rapidly in long-established structure to fulfill urgent demands of development of engineers to fulfill country's demands. Traditionally engineering is focused upon deep investigations in particular field and seeking wider scope of numerous engineering fields.

Now a day both prospects has been offered to student to enable them to select their personal scope of education in alignment with their goals. For student to be competitive and effective in their education and profession it is very much necessary to understand engineering educational abilities at their younger age. They must have to develop capabilities to apply their science and mathematical knowledge skills and techniques to obtain lifelong learning and ability to understand designs, conducting experiments developing analysis, interpretational skills, understanding components, experiments, and problems and finding solutions, develop positivity and sense of responsibility. In STEM education, the act of using science with mathematics to design and develop new technology has become the general definition of engineering education (Yakman, 2018).

2.6. MATHEMATICS EDUCATION AT PRIMARY LEVEL

This subject has history of oldest structured education for learning, and is one of the earliest discipline that has emerged in modern education. The National Council for Teachers of Mathematics is the primary organization that has evolved to guide how this could be taught in K-12 structure. Their methodology have been adopted in different areas as it has arisen from concept that how mathematics could be taught to develop an ability to solve problem in everyday life and in science and technology (Yakman, 2018). Teaching mathematic education is defined in four commons, these are: the subject, the learner, the teacher and milieu of teaching, along with relationship in teaching and learning of mathematics and it aims for society. The last statement regarding relationship to society depicts constructive approach.

Dewey told that mathematical laws are applicable with respect to suitability and substitutability within the system where it exists. It helps student to understand the applicability of this education to society and reflects that how vital it is and interconnected with other discipline of study. When we think the use of mathematics around us, we question ourselves and many of us are not familiar with answers but its matter of thinking that is available to all of us (Yakman, 2018). This statement explains that how mathematical language can be used to address different questions and how based on analysis of fields it could be promoted to approve or disapprove any fact. Science is math based productive technology that is used in analyzing the natural world. Arguably mathematics is the primal language and based for regulation of all other communication.

At every grade level, including primary, middle, and high school, there exists a significant body of mathematics that is both intellectually challenging to learn and widely applicable. These mathematical concepts include reasoning strategies relying on base-ten algorithms at primary level, ratio, proportion, and exploratory statistics in middle school, and algebra, geometry, and data analysis in high school. To effectively teach these topics, teachers must possess a deep understanding of the mathematics taught across different grade levels. To ensure a cohesive curriculum, it is crucial for teachers to recognize the interconnectedness of the mathematics they teach with prior and subsequent grades. For example, a primary school teacher must comprehend how the associative, commutative, and distributive properties combine with place value in algorithms for addition and multiplication of whole numbers. They should also understand the significance of these algorithms for decimal arithmetic in later grades. Similarly, in the middle grades, teachers need to build upon this foundation by guiding students to extend these algorithms accurately to decimals and utilize properties such as distributives when adding and subtracting linear expressions. In high school, teachers further expand on these fundamental concepts when instructing students on calculations involving polynomials and other symbolic expressions (The Mathematical Education of Teachers II, n.d.).

2.7. HISTORY

In 2001, the U.S. National Science Foundation introduced the acronym "STEM," replacing the previous acronym "SMET" with a more captivating and appealing combination of letters. While the acronyms differed, they both conveyed the same concept: science, technology, engineering, and mathematics. However, it was biologist Judith Ramaley who rearranged the letters and popularized the

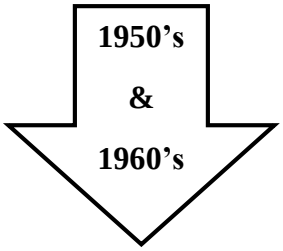
STEM curriculum, which has since made a significant impact on the education systems in the United States and worldwide. STEM education now encompasses early childhood education through to students' transition into the professional world (Williams, 2022).

Initially STEM education was abbreviated as Science, Mathematics, Engineering and technology (SMET) and was initiative of National Science Foundation. Initially the concept of STEM was used in revolutionary industries to teach engineers to develop ability to bring about revolution and inventions, e.g., bulb making, automobile, parts, tools and machines, etc. (White, 2014).

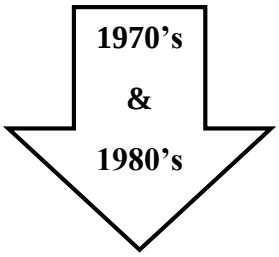
World War II. During World War II American industries flourished, innovation of atom bomb, synthetic rubber and other invention were result of collaboration of scientists, mathematician, engineers and after end of war they promoted STEM Education.

Sputnik. In 1957 launching of Sputkin-1 satellite was really a technological milestone that orbit around the earth in about an hour and a half and encouraged other countries to research for better. USA established NASA and through encouragement and promotion of collaborative efforts between scientist, engineers and mathematicians they become able to reach at moon, NASA has taken many initiative to encourage STEM education.

One fascinating look into the ever-changing landscape of STEM integration in the United States can be observed through the following historical narrative (Sutori, n.d.).



In response to the launch of the Russian satellite, Sputnik, President Eisenhower establishes NASA as the United States' proactive initiative. While a fascination with science had existed for centuries among prominent American figures, this event acted as a catalyst, sparking substantial nationwide enthusiasm. President John F. Kennedy carries forward President Eisenhower's unwavering commitment by advocating for scientific advancements and ultimately achieving the historic feat of landing the first American on the moon.



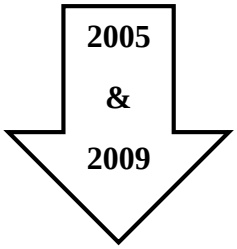
The United States witnessed the emergence of remarkable technological breakthroughs that continue to shape our nation to this day, encompassing innovations such as cell phones and personal computers. Notably, the advent of the artificial heart marked a significant milestone, while the launch of the inaugural space shuttle propelled our country's commitment to numerous national science programs to new heights.

1990's

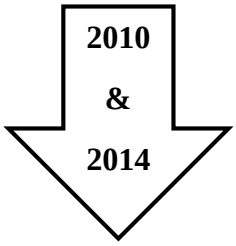
Organizations like NSES (National Science Education Standards) and NCTM (National Council of Teachers of Mathematics) play a crucial role in supporting educators across the United States in implementing standards and guidelines that shape STEM curriculum for K-12 students. It is during this period that the concept is formally recognized with the acronym SMET, which is subsequently revised and improved to become STEM. This adjustment proves to be a wise decision, solidifying the inclusive and interdisciplinary nature of the field.

2001

Governor Janet Napolitano of Arizona takes a significant stride by spearheading the development of a comprehensive STEM agenda for the United States. With successful acquisition of federal and private funding, other states take notice and establish their own STEM councils to bolster this educational initiative. Simultaneously, the No Child Left Behind Act (NCLB) is implemented in response to concerns about the perceived lack of competitiveness in academic pursuits within the United States. This legislation holds schools accountable for ensuring that their students achieve proficiency in academics, aiming to bridge the achievement gap and ensure that no student is left behind.



According to a report released by the U.S. National Academies of Science, Engineering, and Medicine, it was revealed that the United States was lagging behind other countries in terms of proficiency in STEM disciplines. The report shed light on the pressing need for focused efforts to enhance STEM education and address the existing gaps to ensure the nation's competitiveness in these critical fields. This initiative entailed a significant increase in federal investments in STEM education.



Change the Equation - In United States President Obama took initiatives in promoting the NPOs that were dedicated in improving the quality of STEM Education in the country. Selective students undergo the Technology and Engineering Literacy Assessment, designed to assess their comprehension of technology utilization. Additionally, the implementation of the STEM Education Act brings forth significant changes. Furthermore, the act introduces expanded training opportunities for teachers, enabling them to access more advanced programs that enhance their skills and knowledge in STEM education.

The Every Student Succeeds Act (ESSA), a landmark U.S. law enacted in December 2015, plays a pivotal role in shaping K–12 public education policy. Replacing the previous No Child Left Behind Act (NCLB), ESSA introduces amendments to provisions concerning periodic standardized testing for students, while upholding the federal government's expanded role in public education established by the 1965 Elementary and Secondary Education Act. With a focus on fostering student achievement, ESSA stands as a significant reauthorization, aiming to empower every student to succeed in their educational journey.

2.8. IMPORTANCE OF STEM EDUCATION AT PRIMARY LEVEL

Stem education is prime as our world depends on it. Economy is supported by science, technology, engineering and math. STEM centers around showing abilities and subjects in a manner that looks like reality. Students are familiar about realities and a strategy for imagining that can be applied to tackle true issues, by rehearsing STEM Education. Significance of STEM education is discerned by large extent of people, they have started to look for solutions that can better bring STEM education into every classroom. STEM schooling produces basic scholars, increases science education and enables the up and coming age of pioneers. Vocations in STEM related fields are immense and various. They obviously remember vocations for the drug store, energy, programming and

designing fields. Nonetheless, STEM vocations can likewise be viewed as doctor's colleague, network interchanges, horticultural expert, finance, risk examination, and, surprisingly, athletic preparation. All, obviously, educating is a fundamental vocation that invigorates the STEM fields.

By introducing children to STEM at primary level and incorporating it throughout their educational journey, we provide them with ample time to explore possibilities, discover new topics, and nurture their passions. STEM programs, designed to be inviting and inspiring, aim to reshape students' perception of science and foster a hands-on, experiential learning approach. This not only strengthens their grasp of the subject matter but also equips learners of all ages with essential life skills that are highly transferable, including problem-solving, reasoning, communication, creativity, collaboration, and critical thinking. These skills are invaluable, both within the confines of the classroom and beyond. STEM education extends beyond academic subjects, encompassing a skill set that influences our thinking and behavior. By integrating science, technology, engineering, and mathematics at primary level, STEM education empowers individuals with the necessary tools to confront the pressing challenges of our world. It fosters critical thinking, problem-solving, creativity, and collaboration, enabling us to tackle complex issues and make meaningful contributions to society. STEM education equips us with the knowledge and abilities to navigate the intricacies of our rapidly evolving world and shape a better future for all. It goes beyond imparting knowledge; it cultivates a mindset that empowers individuals to approach problems innovatively and find solutions collaboratively. The impact of STEM education on society is far-reaching, shaping the way we perceive and tackle the complex issues of our time (UTEP Connect, 2021).

2.9. CHALLENGES WHILE IMPLEMENTING STEM EDUCATION T PRIMARY LEVEL

An International journal of Stem Education (Margot & Kettler, 2018) explains that the areas identified by teachers as challenges while implementing STEM education at primary level can be structured in six categories:

2.9.1. Pedagogical challenges. A few Teachers see that STEM instructional method requires fundamental changes by the way they establish climate in the classroom and educate, and for certain educators these movements are not positive constantly. Educators are of the view that STEM teaching method needs a central shift away from instructor guidance to student guidance (Park et al. 2017). Educators need to venture out from the immediate job to permit students to find their own specific manners during the lessons that could include unpredicted headings (Lesseig et al., 2016). Another equivalent concern is that educators should have a perspective on guidance that line up with the way of thinking of the STEM educational program writers. Educators likewise have worries about STEM instructional method meeting the different necessities, everything being equal, particularly those with handicaps and numerous mental capacities (Herro & Quigley 2017).

2.9.2. Curriculum challenges. A few educators, particularly at the secondary school level, see the consolidated idea of STEM educational program as a test. Instructors had reluctance to follow others educational program plan (Bagiati & Evangelou, 2015). Educators likewise had worried in coordinating STEM educational program into their current educational plans. Moreover, educators felt that STEM educational program could be unbendable and they

tracked down trouble in joining two unyielding curricular plans (Lesseig et al., 2016). Educators likewise had worried in coordinating STEM educational program into their current educational plans (Asghar et al., 2012). Instructors were additionally seen while Implementing STEM educational program they were found treating the incorporation of explicit substance as a greater amount of a bit of an afterthought (Dare et al., 2014).

2.9.3. Structural challenges. In implementation of STEM education, traditional school structures are considered as barriers. Teachers felt that interdisciplinary nature of STEM lessons was hindered by class scheduling, and some teachers were not considerate in interdisciplinary work while teaching their own subjects. Scheduling also prevented teachers in different subjects from planning together (Lesseig et al., 2016). The construction of student timetables, and absence of adaptability in them, was likewise referred to as an impediment to STEM (El-Deghaidy et al., 2017). Shortfall of command over pacing of educational plan and the succession of guidance were likewise referenced as annoying when educators looked to incorporate various disciplines for credible STEM illustrations (Herro & Quigley, 2017). Locale level instructors detected managerial and monetary backings could be a test to STEM execution (Park et al., 2017). Another bother was a deficiency of innovation assets accessible to students. With inaccessibility of innovation, PCs and different instruments, it was trying to incorporate the innovation piece into STEM examples. Another primary concern noticed was how instruction is coordinated and assessed at the state level (Asghar et al., 2012).

2.9.4. Student concerns. Instructors are sure of that students can't or apathetic to be prosperous with STEM schooling or drives. A few examinations

detailed instructors underestimate student capacities to take care of STEM issues (Al Salami et al., 2017). Such educators didn't believed their students were capable enough in happy regions to apply abilities to independent STEM issues. They suggested a requirement of instructional tools that could be used to motivate students to gain interest in STEM subjects. Besides, countryside educators saw difficulties related with adjusting the educational plan to address the issues of failing to meet expectations of students (Goodpaster et al., 2012).

2.9.5. Assessments, time, and knowledge. Teachers perceive that insufficiency of knowledge of STEM disciplines, assessment tools and planning time are hindrances and barriers to STEM initiatives. Instructors fingered there were not sufficient developmental evaluations to figure out what ideas understudies comprehended from different disciplines (Dare et al., 2014). Likewise, educators were restless about group reviewing. They felt reluctant in evaluating every individual from the gathering exclusively to ensure they had dominance on the guidelines (Herro & Quigley, 2017). Expanded responsibility related with STEM programming ended up being a worry to instructors. Additional time was expected to educators in arranging with other branches of knowledge and to set up the materials for students. Introducing the material and taking into account shifting capacity levels among students likewise demanded greater investment (Park et al., 2016). Instructors additionally affirmed they had nonappearance of topic information concerning STEM content. Pre-administration and in-administration preparing was taken as deficient in getting ready educators to execute STEM. Educators searched for accuracy about how the program should be carried out into existing projects (Nadelson & Seifert, 2013).

2.9.6. Students Engagement. Teachers often face a significant hurdle in engaging students, given the prevalence of smartphones, misconceptions about STEM subjects being difficult and unapproachable, and uninspiring learning materials. Sustaining students' attention for extended periods can be a daunting task. However, one proactive approach to address this challenge is to foster a genuine love for scientific exploration and discovery from an early age. By integrating STEM lessons into the daily curriculum, educators at the primary level of education can help children develop a foundational understanding and curiosity about the world around them. This proactive step not only introduces young learners to STEM concepts but also cultivates a sense of wonder and inquisitiveness. By nurturing a positive engagement with STEM subjects early on, teachers can lay the groundwork for lifelong learning and a lasting passion for scientific exploration (Learning, 2021).

2.9.7. Going digital. Teachers and educators often face demanding and unpredictable workloads, leaving limited time for planning intricate and captivating STEM lessons. However, technology emerges as a valuable ally in this regard. According to the EPI (Education Policy Institute), teachers who incorporate technology into their class projects in a consistent manner find themselves with four to five extra hours each week, compared to those who only sporadically employ educational films and quizzes. Educational films, in particular, serve as a swift and enjoyable method to capture students' attention, while also initiating effective teaching techniques like flipped classrooms. By leveraging technology in the classroom, teachers can optimize their instructional time, engage students through interactive and multimedia experiences, and provide opportunities for independent learning. This integration of technology not only

enhances the learning experience but also empowers educators to effectively manage their workload, allowing for more focused and impactful STEM instruction (Learning, 2021).

2.9.8. Gender gap. Despite notable progress, the gender disparity in STEM fields remains pronounced, with men outnumbering women significantly. While advancements have been made from the era of the male-breadwinner model, barriers to entry for young girls pursuing STEM studies still persist. Although we now have a greater number of children in STEM, showcasing exemplary role models, inequalities persist in the opportunities afforded to those who successfully break into STEM careers and academia. Girls in STEM often encounter challenges within boys-dominated classrooms and laboratories, which can result in feelings of isolation, exclusion, and even outright marginalization. Overcoming these obstacles and fostering an inclusive environment remains crucial for ensuring that all aspiring individuals, regardless of gender, have equal access to opportunities within STEM fields. Addressing these systemic issues is essential to cultivating a diverse and equitable STEM community that empowers and supports the success of girls in these disciplines (Learning, 2021).

2.10. PROSPECTS OF TEACHERS TO IMPLEMENT STEM EDUCATION AT PRIMARY LEVEL

According to an International journal of Stem Education (Margot & Kettler, 2018) the followings ways that teachers might need an additional support in implementing STEM Curriculum at primary level are the following:

2.10.1. Collaboration. Instructors acknowledge as obvious that a culture of coordinated effort would improve the practicality of STEM programs (Herro

& Quigley, 2017). They expounded the significance of helping out other STEM educators and college experts for simply not exclusively to lay out a climate that supports groundwork for STEM examples, yet in addition to demonstrate a group way to deal with primary level students. STEM instructional method expected students at primary level to team up to settle difficulties, so an instructor demonstrating the strength of a gathering approach is gainful. For trans disciplinary teaching required for STEM lessons, collaboration was considered essential by many teachers (Herro & Quigley, 2017). For teaching and planning in different disciplines greater planning time was required to teachers throughout the school year. Teachers also suggested that technology enabled network could be a reliable mean for relating and collaborating between content area teachers. Open communication between teachers, chances for collaborative planning and providing sufficient time could be vital to successful implementation.

2.10.2. Curriculum. Educators thought openness about a quality educational program would upgrade the chances of progress for STEM drives (Haneghan et al., 2015). Educators considered the meaning of an adaptable educational program that is designing based. Compelling educational plan should be sufficiently adaptable to be utilized with different capacity levels and instructive conditions though as yet being centered around the designing plan process (Lehman et al., 2014).

2.10.3. District support. Instructors acknowledged school area backing, direction, and adaptability were fundamental elements for STEM drives. In undeniable reality, school area support was referred to as the most impacting element to STEM outcome in two of the examinations (McMullin & Reeve, 2014). By other studies it was stated as an important factor (Park et al., 2016). A steady

manager or regulatory group is prime for instructors while carrying out STEM teaching method at primary level. Furthermore, the K-12 curricular structure or extension and grouping ought to be rebuilt to consider STEM programing (Herro & Quigley, 2017).

2.10.4. Prior experiences. Educators expressed that previous work on utilizing student focused, request models of guidance work with achievement in a STEM drive. Similarly organized related involvements by educators were regularly viewed as advertisers to STEM achievement. Educators who have had more exposure to science or math courses during their schooling at primary level (Park et al., 2016), or have employed comparative informative strategies such as issue-based learning, inquiry-based learning, problem-solving approaches, and guided independent research (Park et al., 2017), reported that these experiences have supported the development of inductive and deductive thinking skills crucial for STEM disciplines. These diverse educational backgrounds and teaching strategies contribute to fostering critical thinking abilities that span across disciplines and are essential for success in the STEM fields (Park et al., 2017). Because of these prior experiences level of confidence with STEM pedagogy increased.

2.10.5. Professional development. Educators believe in efficient and regularly accessible expert learning valuable open doors, which would help effective STEM drives. Every now and again referenced help that would improve the viability of STEM instruction was learning potential opportunities for educators to build their capacity to estimably acclimatize STEM content into their educational program. At different stages, educators in their vocations expressed critical ascent in their certainty, information, and viability to show

STEM in the wake of going to proficient advancement programs (Lesseig et al., 2016). Time is expected for viable expert turn of events or proceeding with instruction needs for educators to investigate how STEM can be integrated inside their educational plan alongside focusing on expanding their substance information and encounters with STEM.

2.10.6. Innovative teaching. Science may appear dull and disconnected from the real world when it lacks contextualization. Without effective illustrations, concepts can seem abstract and devoid of purpose. The Institute of Engineering and Technology conducted a study revealing that many students perceive the curriculum as uninteresting and detached from life beyond the classroom at primary level. However, when concepts are presented through hands-on activities, students can more readily establish connections between their observations and theoretical knowledge. Engaging in practical project work not only facilitates a deeper understanding of scientific concepts but also promotes valuable skills for the 21st century. Group discussions, teamwork, communication, and peer-to-peer interactions thrive during these experiential learning opportunities. By fostering an environment that encourages practical engagement, science education becomes more vibrant, relevant, and equipped to develop essential skills that students can carry forward in their academic and professional lives (Learning, 2021).

2.11. RESEARCHES ON STEM EDUCATION

Some of the recent researches on STEM Education are the following:

Karademir & Yıldırım conducted a research in 2021 which aimed to determine the views of thirty pre-service preschool teachers recruited using convenience sampling on STEM education and engineering. They used Phenomenological design. Data were collected using a semi-structured interview form and analyzed using inductive content

analysis. Participants offered different definitions of STEM education and thought that it could have contributions in numerous aspects. They also remarked that preschool STEM education on civil and computer engineering skills made teachers better equipped. They mentioned designs and projects for preschool STEM education as well. Results suggest that preschool undergraduate education should integrate STEM activities and offer workshops and trainings to change pre service preschool teachers' misconceptions about engineering.

Farwati, Metafisika, Sari, Sitinjak, Solikha, & Solfarina in 2021 conducted a qualitative research to map all research themes related to the implementation of STEM education in Indonesia in the science field and the scientific clumps of science from 2015-2020,starting from elementary school to tertiary education levels. They used Arksey and O'Malley's five-stage framework. They found 597 articles that match to this framework and 154 articles that meet the criteria as research data. The results showed that the STEM education is implemented as a learning strategy and approach, integrated with other learning models, used as a learning assessment, and developed into teaching materials, modules, and learning media. Additionally, teachers implement STEM to improve entrepreneurship skills, learning motivation, and various 21st -century skills in their students. Furthermore, research on STEM has been conducted in 19 provinces in Indonesia, which are dominated by West Java and East Java provinces (Farwati et al., 2021).

Hackman, Zhang, & He in 2021 conducted a mixed method research. This research describes a novel study on Liberian science teachers' attitudes, and it seeks to elucidate and comprehend the current attitudes toward STEM education among science teachers and identify the factors that might influence these attitudes. A questionnaire was designed to examine attitudes towards STEM

education among 194 in-service science teachers and was reinforced by interviews with 10 science teachers. A significant difference was observed between private and public-school science teachers with respect to their overall attitude scores. A marginally significant difference was found among teachers from different grades. Findings from regression analysis showed that professional and administrative support, peer collaboration, STEM training, and teaching time positively influence science teachers' attitudes towards STEM education (Hackman et al., 2021).

Çiftçi, Topçu, and Foulk conducted an exploratory research in 2020 to explore pre-service primary level teachers' views on STEM education and their STEM teaching practices. They emphasized a strong relationship among characteristics of STEM education and the early childhood period, such as investigation, exploration and observation, communication and playing. An open-ended questionnaire and STEM integrated lesson plans were used as data collection tools. They analyzed the data through content analysis and descriptive analysis. The research group consisted of 91 pre-service early childhood teachers studying at two universities in Istanbul, Turkey. As a result, the themes of 'Contributions of STEM Education', 'Why STEM Education is Suitable at primary level' and 'How to Bring STEM Education into Early Childhood Education' were obtained based on pre-service primary level teachers' views.

Pau Ling Chia and Siti Mistima Maat conducted an exploratory research in 2018 on secondary school teachers' attitude towards integrated STEM in Malaysia. They took the sample of Fifty-five secondary school teachers purposively who attended the seminar on STEM awareness. This STEM Survey was adapted from S. S. Guzey, M. Harwell, and T. Moore was used to collect

data which contains 28 items of 5 points Likert scale with five paradigms of attitudes. These comprise attitude towards science, attitudes towards technology, attitudes towards engineering, attitudes towards mathematics and attitudes towards integration of STEM. The researcher founded that teachers' attitudes towards integration of STEM was generally positive. The positive attitudes towards STEM among the teachers can accelerate the forming of integrated STEM education.

Ghaddah Al Murshidi in 2019 conducted a qualitative research to explore the challenges and possibilities of science, technology, engineering, and mathematics education in the United Arab Emirates. Total 63 articles were reviewed and they included government reports, innovative publications, primary research studies, and theoretical analysis. The material of these articles were developed to carefully amalgamate research on the recent attitude of STEM education in the UAE, as well as the challenges faced, and projected possibilities. The researcher found that the UAE has made better progress but is limited by challenges such as lack of interest in STEM fields by UAE nationals and, the inaccessibility of STEM education across all age groups and income earners. The researcher recommended that still there is need for intensification of effort on personal and professional development for teachers of STEM which will consequently affect the interest of students in STEM fields. Also, STEM education should be made accessible across all age groups and all citizens, regardless of their financial status.

CHAPTER 3

METHODOLOGY AND PROCEDURE

In the present chapter, we have thoroughly examined and presented the methodology and procedures employed in the study. The researcher described the research approach, research design, population of the study, sample size, sampling technique, developing and administrating the instrument of the study to collect data, data analysis, ethics of the research and timeline. This study was conducted as a mixed method research to examine and explore the prospects and challenges of implementing STEM Education: from the perspectives of primary school teachers.

3.1. RESEARCH APPROACH

The current study employed a mixed method research design.

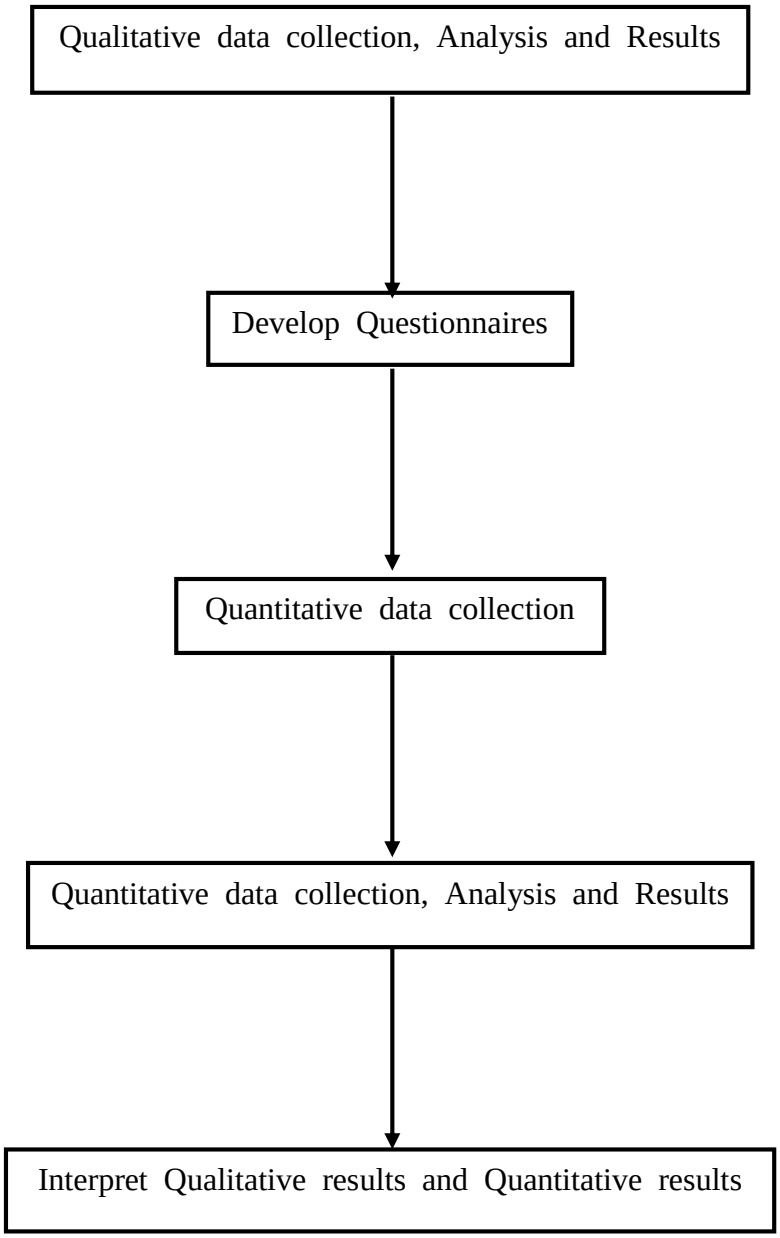
A mixed-method research design is an approach used to collect, analyze, and integrate both quantitative and qualitative research methods and techniques within a single study, aimed at comprehensively addressing a research problem.

3.2. RESEARCH DESIGN

In this mixed method research, exploratory Sequential design was used to conduct this study.

Exploratory Sequential design is a methodological approach that examines research questions that have not recently been concentrated on top to bottom (Creswell, 2018). Exploratory research often leans towards qualitative methods.

However, it is worth noting that a large-scale survey conducted in an exploratory manner can also incorporate quantitative elements.



Researcher collected the qualitative data and analyzed it. Then the researcher developed the questionnaires. Then the questionnaire was validated from the subject expert. After that the data was collected and then analyzed.

Exploratory sequential design was used because the data collection process was challenging due to a less number of schools which were implementing

STEM Education. So the researcher used two sets of results together so that the quantitative results can be verified by qualitative results.

3.3. POPULATION

The population of this research was comprised of 1000 teachers of private schools in Lahore. There are 4400 registered and 5000 unregistered private schools in Lahore. Out of which 200 schools are implementing STEM Education in their curriculum. There are 1000 Primary level teachers in these schools.

Registered schools	Unregistered schools	Schools implementing STEM Education	Total no. of teachers
4400	5000	200	1000

3.4. SAMPLING TECHNIQUE

Exploratory mixed method research was started with qualitative and then followed by quantitative research. Purposive sampling was done for the selection of participants for focus group and simple random sampling was done for the selection of participants for questionnaires. Focus group method was used and then was followed by random questionnaires.

Purposive sampling was used in this study because the researcher had a clear idea of the objectives she was interested in studying and wants to use this so that it could be representative of those objectives.

3.5. SAMPLE SIZE

A sample refers to a smaller, representative subset of a larger population. It contains the essential characteristics of the population it represents. Samples

are employed in statistical testing when the population size is too large to include every possible element or observation in the study (Kenton, 2019).

The sample for this mixed method research study for focus group participants was 5% of which there were 50 teachers of primary level and sample for questionnaires was 21% of which there were 214 teachers (Cohen & Manion, 2007) of primary level from of differing sizes, educational backgrounds, and other demographic differences. These teachers were chosen for nearer thought both for their likenesses to the research establishment depicting the demographic qualities and for their disparities from one another. These percentages of teachers were selected because according to the concept of Cohen and Manion sample for 1000 no of population for quantitative data was 21% and for qualitative data was 5%.

Table No 3.1.

Sample size ***(n = 214), (n = 50)***

	Grade	**No. of Teachers**
Qualitative (Focus Group)	1^{st} - 5^{th}	5 % = 50
Quantitative (Questionnaires)	1^{st} - 5^{th}	21 % = 214

(Cohen & Manion, 2007)

3.6. SECTION 1 QUANTITATIVE APPROACH

3.6.1. Research instrument. The research employed a questionnaire as a data collection instrument to gather information from respondents. The

questionnaire consisted of structured items presented on a Likert scale. Personal distribution of the questionnaire was carried out to reach the intended participants.

3.6.2. Questionnaire construction. A self constructed 5 point likert scale questionnaire was developed for getting empirical data from school respondents. The only variable was under the heading of six subscales such as science, technology, engineering, mathematics, prospects in implementing STEM Education and challenges while implementing STEM Education. For the collection of self-administered ordinal data, an item bank was developed to ensure a comprehensive set of items. The item bank was developed from the relevant review of literature and its validity and reliability was examined. Shivany (2013) suggested that the Likert scale is appropriate when using a survey method for data collection, allowing respondents to express their perspectives. The Likert scale is an ordinal measurement scale for assessing agreement or disagreement (Mcleod, 2008). Questionnaires have been commonly used for data collection, as described by (Hussy & Hussey, 1997). Gay (1996) defines the questionnaire as a suitable tool for gathering data when personal interviews are not feasible due to logistical constraints.

In this study, the STEM Education scale was constructed using a five-point Likert scale ranging from strongly disagree to strongly agree. This scale is consistent with the Likert scales used by Dilshad (2009) and Akhtar et al. (2010) to measure the perceptions of teachers and students. After conducting a validity pilot study, the initial questionnaire consisting of fifty-eight items was refined to a final version with thirty-two items, ensuring both reliability and relevance, the details are as follows:

3.6.3. Validity. When a study gives an authentic narration of the participants, subjects and the surrounding that is under study, then the study is said to be credible (Miles, et. al, 2014). Healthily performed quantitative research provides itself credible outcomes as it offers a healthy, bold explanation of the respondents which leads to well understand the process being planned (Merriam, 2009). Similarly, according to McDaniel & Gates (1996), several important considerations need to be addressed before administering research instruments. He said that it is crucial to clearly define what is to be measured or assessed by the instruments. And he recommended to pre-test i.e. pilot testing the items or questions included in the instruments to assess their clarity, comprehension, and effectiveness. And he advised of involving experts for valuable insights and feedback regarding the relevance, appropriateness, and validity of the instrument items.

3.6.3.1. Face validity. The first step in establishing the validity of the questionnaire is typically to determine its face validity. Experts in the field, including educationists, scholars, researchers, and quality management system supervisors, assess the questionnaire to ensure that the items effectively capture the topic under study. These experts evaluate whether the questionnaire adequately addresses the research objectives and if the items align with the intended constructs. Face validity is established through the valuable insights and expertise provided by scholars, researchers, and supervisors in the field. These people have sufficient knowledge. Two of them taught secondary education subjects at Graduation level with approximately 10 years of teaching experience and two of them taught STEM Education subjects at MPhil and PhD level with a lot of teaching experience. The feedback from the supervisors, scholars and

researchers was used to make necessary adjustments to the questionnaire items like the researcher adding items that matched the given conceptual domain of the study.

3.6.3.2. Content validity. Best & Kahn (1999) emphasize the importance of establishing the content validity of the questionnaire and interview by presenting them to a panel of experts. In this study, content validity was ensured through expert evaluation. A psychometric expert was involved in examining the construction of the items to identify common errors such as confusing, leading, or double-barrel items. Expert judgment was used to assess the content validity of the questionnaire items. Four experts, including the study supervisor, quality experts, and PhD teachers, validated the questionnaire. The supervisor also reviewed and confirmed the accuracy of the concepts being measured. The instrument's validity was established through the opinions of experts in the field, ensuring the robustness and relevance of the research study.

These people had sufficient knowledge. Two of them held a PhD degree in stem education with 10 years of teaching experience and two of them had a PhD degree in secondary education with a lot of teaching experience.

In the questionnaire, two response options were provided on the right side of each item, indicating “accepted” (A) and "rejected" (R). This approach allowed for the inclusion of 80% of the items that were considered acceptable. Additionally, an additional page was included for participants to provide comments and suggestions. This allowed for necessary revisions and modifications to enhance the validity of the research instrument. The researcher personally met with experts to engage in discussions about the questionnaire, seeking their input and expertise to further refine the instrument. These steps ensured that the

questionnaire was carefully reviewed and improved through collaboration with knowledgeable individuals in the field. According to expert's suggestions, researchers remove confusing items, double – barrel items and improve common errors in the survey instruments.

3.6.4. Pilot study of the instrument. This involves conducting a trial run or a small-scale version of the study to gain insights into the major research project. Wnter and Dodou (2012) suggest that pilot testing is used to measure the reliability of the research instrument. Mugenda (2008) agrees that the pilot study should include 10-20% of the sample size for testing, with 1% to 10% being on the lower limit. Connelly (2008) presents literature suggesting that a 10% sample size for the pilot study would be appropriate for a large-scale project. However, Hertoze (2008) explains that determining the sample size is not straightforward and depends on various factors and strategies. Additionally, Johanson and Brooks (2010) describe that the sample size for the pilot study depends on the specific purpose of the study. In this case, 174 teachers were selected for the pilot study after the modification of the questionnaire. The pilot study was conducted in primary schools with teachers, and after the pilot testing, the questionnaire was refined based on the feedback and insights gained from the pilot study. Before the questionnaire was refined there were 53 statements through which pilot study was conducted. After the pilot study the questionnaire was refined to 32 statements.

Following statements were removed from the questionnaire after the pilot testing:

A. Science

1. I know integrated science has been replaced by basic science.
2. I know elementary science has replaced by basic science and technology.
3. Students design and conduct their own scientific investigations.
4. I have difficulty teaching science with laboratory work.

B. Technology

5. I know introductory technology has been replaced by basic technology.

C. Engineering

6. Teachers believe that struggle and even failure are essential components of the engineering design process within STEM Education.
7. It is boring subject.

D. Mathematics

8. Finds the real life problems related to mathematics topics.
9. Only few topics in mathematics can be implemented in STEM Education.

E. Prospects in implementing STEM Education

10. I am someone who easily accepts new experiences related to STEM.
11. Teachers exchange teaching ideas, learning materials, STEM resources.
12. STEM teaching requires some fundamental shifts in how they establish classroom environments and teach students.
13. Age, gender, and STEM experiences of teacher's plays a role in their perceptions of STEM Education.
14. School district support, guidance, and flexibility are necessary for STEM initiatives.
15. Well-organized and frequently available professional learning opportunities facilitate successful STEM initiatives.

F. Challenges while implementing STEM Education

16. No teamwork.
17. The unsupported school management in providing adequate time and funding.
18. Teaching is affected by insufficient number of Internet-connected computers.
19. Teachers' insufficient comprehension toward STEM.
20. Insufficient teacher training workshops.
21. Teachers believe that students are unable or unwilling to be successful with STEM Education or initiatives.

3.6.5. Reliability. The reliability of the questionnaire was assessed on a pilot scale through respondents. Cronbach's alpha, which is a widely used statistic for reliability assessment (Cronbach, 1951), was employed. Cronbach's alpha measures the average correlation or internal consistency of the survey instrument (Kothari, 2008). Typically, Cronbach's alpha ranges from 0 to 1. According to George and Mallery (2003), there are some rules of thumb for interpreting the reliability coefficient. A reliability coefficient of 0.7 is generally considered acceptable, while a coefficient of 0.6 is also deemed acceptable for a new questionnaire. This finding aligns with the study conducted by Al-Rafaie, Ghanimat, and Li (2012).

The extent to which an instrument accurately measures its intended target is known as reliability. Different methods, such as test-retest, equivalent-form, and split-half, are employed to assess reliability. Internal consistency refers to the degree of consistency among items within a construct, both collectively and individually, indicating construct homogeneity. Cronbach's alpha is a commonly used technique to measure inter-item consistency, while the Kuder-Richardson formula (KR-20) is suitable for dichotomous items. According to Sekaran (2003), a perfect reliability coefficient of 1 indicates higher reliability, with coefficients

ranging from 0 to 1. In the social sciences, a reliability coefficient of 0.6 is generally considered acceptable. In the researcher's study, Cronbach's alpha was used to measure the reliability of the questionnaire administered to teachers. Initially, the questionnaire consisted of fifty-eight items. However, after undergoing validity assessment, pilot testing, and reliability analysis, the final questionnaire included thirty-two items. The researcher employed the strategy of internal consistency reliability analysis to evaluate the consistency among the items within the questionnaire. Cronbach's alpha was adopted as the measure of reliability for the questionnaire.

3.6.5.1. Item internal consistency reliability (Cronbach alpha)

Table No 3.2.

Reliability Results, Internal Consistency of the Questionnaire

Subscales	Items	Alpha Coefficient
Science	7	.591
Technology	4	.605
Engineering	4	.682
Mathematics	5	.592
Prospects in implementing STEM Education	18	.824
Challenges while implementing STEM Education	18	.791
Overall reliability of scale	58	.868

Number of items = 7

Alpha = 0.591

During the initial testing phase, the results revealed an alpha coefficient of approximately 0.591 for the 7 items. This value suggests that the items demonstrated a moderate level of internal consistency. The reliability of the instrument was deemed acceptable, as values between 0.6 and 0.9 are generally considered reliable.

Number of items = 4

Alpha = 0.605

In relation to technology, the likert items showed an alpha coefficient of 0.605 for the four items. This indicates that the items exhibited a good level of internal consistency.

Number of items = 3

Alpha = 0.682

Regarding engineering, the likert items displayed an alpha coefficient of approximately 0.682 for the three items. This suggests that the items exhibited a relatively high level of internal consistency.

Number of items = 5

Alpha = 0.592

Regarding mathematics, the likert items demonstrated an alpha coefficient of approximately 0.592 for the five items. This suggests that the items had a relatively high level of internal consistency.

Number of items = 18

Alpha = 0.824

Regarding the prospects in implementing STEM Education, the likert items showed an alpha coefficient of approximately 0.824 for the eighteen items. This suggests that the items had a relatively high level of internal consistency.

Number of items = 18

Alpha = 0.791

On challenges while implementing STEM Education, the alpha coefficient for the eighteen items was approximately 0.791, indicating a relatively high level of internal consistency.

The alpha coefficient for the 58 items in the teachers' Likert scale was calculated to be 0.868, indicating a high level of internal consistency. This high alpha value suggests that the items related to this variable were highly reliable and consistent.

3.7. DATA COLLECTION

Different sources of Data collection was used by Researcher including primarily guidance from (HOD) Education department. Secondly, permission was taken from the school authorities to conduct the study. Data was collected personally by the researcher. Questionnaire were briefed and provided to multiple participants but some did not respond appropriately. Considering the response rate only fully completed questionnaire were finalized for research. Mean is used for data Analysis. Questionnaire was chosen as the preferred data collection tool because it was easy to administer, requiring minimal effort and resources it offered a cost-effective approach compared to other data collection methods and is an efficient way to collect data from a large number of participants

simultaneously. Additionally, the questionnaire format allowed for easy analysis of the collected data, facilitating the extraction of meaningful insights. It is convenient to participants to provide simple and quick responses, contributing to a smoother and more efficient data collection process. According to Mugenda (2008), The response rate of 5 % or above is adequate for analysis of data. But I achieve total response rate of 81%.

Table No 3.3.

Response rate of the respondents

Categories	level	Questionnaires send	Questionnaires return	Questionnaires discarded	Questionnaires used	Response rate
			31 schools			
Teachers	Primary	280	226	12	214	81 %

3.7.1. Follow – up procedure. To increase the response rate, it is necessary to follow certain procedures. One effective approach is to conduct personal visits as reminders, as they may result in additional responses. The researcher made an effort to contact the participants whenever possible. Some participants completed the questionnaire on time, while others requested another copy due to misplacement. When the researcher reached out to the teachers to fill out the questionnaires, many expressed delays in returning them due to their busy schedule with academic activities. It is important to note that while a response rate below 70% may weaken the conclusion validity, a 100% response

rate should not have an adverse impact. The researcher acknowledges the challenges in obtaining a high response rate and recognizes that the focus should be on obtaining quality responses rather than solely aiming for a perfect response rate.

3.8. DATA ANALYSIS

The questionnaire was analyzed by using SPSS (Statistical Package for the Social Sciences). Descriptive statistics was used in this study to analyze the data from the questionnaires. Descriptive statistics was used for Mean, Frequencies and Percentages. Descriptive analysis was done to conclude the distributed data while detecting the errors and outliers. It was done to provide descriptions of perceptions of teachers about STEM Education and challenges faced by them while implementing STEM Education. It was done because the researcher was doing investigation of the particular objectives which could only be done by using descriptive analysis. Name of the Respondents were kept confidential so that any conflict may be avoided.

According to Moidunny (2009), the interpretation of mean scores is as follows:

1. Mean scores ranging from 1.00 to 1.80 are considered very low.

2. Mean scores ranging from 1.81 to 2.60 are considered low.

3. Mean scores ranging from 2.61 to 3.20 are considered medium.

4. Mean scores ranging from 3.21 to 4.20 are considered high.

5. Mean scores ranging from 4.21 to 5.00 are considered very high.

This scale allows for the categorization and interpretation of mean scores based on their respective ranges, providing a framework for understanding the level of a particular variable or construct being measured.

3.9. SECTION 2 QUALITATIVE APPROACH

The research is based on the prospects and challenges of implementing stem education: teachers' perspectives at primary level. Teachers of the primary level formed the population of the study. In sum, there were 10 groups in which there were 5 teachers were selected. A focus group is a research method that involves gathering a small group of individuals in a moderated setting to answer questions and discuss a specific topic of interest. Focus groups can be categorized into various types, each serving different purposes and having unique characteristics. These types include: Single Focus Group, Mini Focus Group, Two-Way Focus Group, Dual Moderator Focus Group, Dueling Moderator Focus Group, Respondent Moderator Focus Group, Remote Focus Group.

Figure no: 3.1

Types of Focus Group

In the present study, the focus group method was employed, and purposive sampling was used to select participants for the focus group. The selection of participants was based on their affiliation with the school under study. Specifically, the researcher opted to interview the most experienced primary level teachers, as they were expected to possess extensive knowledge and awareness of STEM Education. This deliberate selection aimed to gather valuable information and insights from individuals who could provide in-depth perspectives on the topic. By including experienced teachers, the focus group discussions aimed to capture a rich understanding of STEM Education based on their expertise and experiences. Every focus group discussion took between 15 – 20 minutes to answer the questions. Focus groups discussion enabled data collection. A guide was prepared for the research questions.

i. **Pre – focus group stage.** Before research selection process is aimed to include individuals who possessed relevant knowledge and experiences related to the research topic. Once the participants were determined, the researcher took the necessary steps to organize the interview session in detail. This included arranging the venue, specifying the time, and setting the date for the focus group. By meticulously planning these logistical aspects, it is ensured a smooth and efficient conduct of the focus group, creating a conducive environment for meaningful discussions and valuable insights to be shared.

ii. **During the focus group stage.** The focus group session commenced with the researcher providing a brief overview of the planned questions to the participants, including an introduction to the opening and closing questions. The researcher initiated the session by engaging in informal conversation, which involved greetings, self-introduction, and non-verbal cues

such as maintaining eye contact and smiling. Establishing a good rapport with the participants was deemed crucial for facilitating open and voluntary communication during the session (Jacob & Furgerson, 2012). The researcher proceeded to explain the nature and purpose of the study to the respondents, ensuring they understood the objectives and their role in providing valuable insights. Following the focus group protocol, the researcher took comprehensive notes to capture the rich information shared by the participants. The entire session typically last around 15 to 20 minutes. Concluding the session participants are provided opportunity to provide insight and comments. And in end they were expressed with gratitude and appreciation. Finally the data was entered in software for analysis.

iii. Post – focus group stage. The post-focus group stage is crucial for synthesizing the information gathered during the session and deriving meaningful insights that contribute to the overall research goals. Considering this researcher purposed a focus group based on three open ended questions and STEM literate teacher were selected as participants. Purposive sampling techniques was used for the said objective and the validity was established by three experts. A pilot study was conducted with two groups. Word cloud was used for interpretation of data.

Sample of Focus group discussion. The sample questions for focus group discussion are the following:

1. Which teaching skills are most required in implementing STEM curriculum?

2. Which challenges teachers faces while implementing STEM Education?

3. What teachers feel that these will be the elements which will make the implementation of STEM Education easy in the classrooms?

3.9.1. Pilot study. Pilot studies serve the purpose of identifying potential issues that may arise during an interview, such as repetitive questions, question misinterpretation, and question length. By conducting pilot studies, researcher was able to gain valuable insights into the interview process, ensuring that the questionnaire is clear, concise, and effectively measures the intended variables. This preliminary testing allows for necessary modifications and improvements to be made before the actual interviews take place. Ultimately, pilot studies help refine the interview instrument and enhance the quality of data collection by addressing any potential challenges or limitations. This remedy provided clear directions. Each interview required approximately 15 – 20 minutes. A pilot interview was conducted with two groups containing 10 participants, 5 in each group.

3.10. DATA COLLECTION

Researcher visited 10 schools for the focus group discussion with the teachers. The teachers were supportive, some were busy so they didn't gave proper time. Ample time was given to participants to answer the questions. Once data collection was completed it was further entered for analysis. Data collection was conducted through personal visits of the researcher to the sample schools. During these visits, participants were assured that their collected information would be treated with strict anonymity, and confidentiality would be maintained. The participants were made aware that their responses would be aggregated and reported in a way that no individual or institution could be identified. This commitment to preserving anonymity and confidentiality was

emphasized to enhance trust and encourage honest and open responses from the participants.

3.11. DATA ANALYSIS

The focus group discussion was audio taped and notes were taken. Subsequently, a detailed report was made of each focus group discussion. For each focus group, all statements relating to STEM education were marked in the report. These statements were listed in a data file in order to obtain a comprehensive list of the relevant statements and issues from the total number of group discussions. Data was interpreted by word cloud generator.

3.12. RESEARCH ETHICS

It was significant to guarantee that the research was accompanied with the maximum ethical principles. Seidman (2013) noted that there were several stages that a researcher could yield to reduce the threats to participants, which includes to provide the informed consent documents. The researcher should make sure that he data collected must not be misused and the researcher must struggle to ensure the anonymity of the participants. This was chiefly significant in a research which inquires the contestants to reflect on a question as particular. To guarantee that this research was completed ethically, various parts were took into contemplation.

First, all of it was necessary that the participants would give their informed consent to take part in this study. Gaining informed consent from each of the participant helped to guarantee that the participants willingly participated in the research and they had full information about the purpose of this study, choice,

and possible dangers and profits connected with this research. Moreover, for securing informed consent from each of the participant of the research, various measures were taken to confident the information collected from the participants. It was for the purpose that the data was kept secure on password protected laptop, therefore the confidentiality of the participants was protected.

3.13. TIME SCHEDULE

The current study took approximately fifteen months to complete. Three months were required for making a research proposal, further the topic was finalized by the supervisor. Four months were required for collecting the data. After that two months were required for data analysis. Further four months were required for the completion of the research in the form of complete thesis book including the five chapters.

3.14. METHODOLOGY SUMMARY

The chapter encompasses a comprehensive overview of the research methodology, design, and various concepts and issues relevant to the research. It offers insights into the rationale behind specific sections of the design and methodology employed in the present study. Additionally, the chapter delves into the details of instrument selection, data collection procedures, and analysis techniques utilized. By providing this information, the chapter establishes a solid foundation for understanding the research process and ensures transparency in the methodology employed for the study.

CHAPTER 4

DATA ANALYSIS AND INTREPRETATION

This chapter presents the analysis and interpretation based on data. It was a mixed method exploratory sequential research. The study was designed to look for the prospects and challenges faced by teachers while implementing STEM Education at primary level. The procedure for the data collection and analysis was carried by means of questionnaires and focus group. The questionnaires were administered to 214 teachers of the primary level from grade one to grade five and all were received back. Return rate was 100 %. The duration of data collection was four moths (120 days). Questionnaires were filled by all the teachers of primary level below one to grade five in about 20 - 25 minutes. Focus group was conducted by the primary level teachers and were divided in ten groups each consisting of five teachers. The duration of focus group was approximately 10 - 15 minutes. The quantitative data was analyzed by applying descriptive statistics and qualitative data was analyzed by word cloud generator. Descriptive statistics for quantitative data analysis included Mean differences, Frequencies, Standard Deviation and Percentages. Sampling error was calculated to judge the adequacy of the sample. Findings, conclusions and recommendations were made. Thereafter, analyzed data along with its interpretations was presented in tables.

4.1. Descriptive Statistics

Descriptive statistics provide a comprehensive overview of a sample by employing procedures to organize and summarize the data. These statistical

techniques enable us to effectively communicate and describe the significant characteristics of the sample data. By condensing and presenting information in a concise and meaningful manner, descriptive statistics offer valuable insights into the distribution, central tendency, variability, and other essential features of the dataset. This allows researchers and analysts to gain a clear understanding of the data's key characteristics and make informed interpretations (Heiman & Gary, 2011). The following table shows the percentages, means and frequencies of the variable under study.

Table No 4.1.

Teachers perspective about science ***(n = 214)***

S. No	Science	SD	D	N	A	SA
1	Experiments are used in the classroom to explain the subject matter.	1 %	1 %	1 %	27 %	70 %
2	Scientific ideas are presented and explained to the whole class.	1 %	2 %	17 %	58 %	22 %
3	I use content from different subjects to explain scientific concepts.	3 %	5 %	37 %	26 %	29 %

Table 4.1. shows percentage of responses of teachers perspective about science, 70 % teachers were strongly agreed that they uses experiments while delivering lecture in classroom. 2 % teachers disagreed that they use scientific

ideas to explain data to whole class. 26 % teachers were agreed that they use content from different subjects to explain scientific concepts.

Table No 4.2.

Teachers perspective about Technology (n = 214)

S. No	Technology	SD	D	N	A	SA
1	Different types of materials (visual, audio, written) are used in teaching.	6 %	5 %	12 %	22 %	55 %
2	I actively search the web for relevant teaching resources.	3 %	4 %	29 %	51 %	13 %
3	Students are taught using multimedia.	6 %	14 %	29 %	21 %	30 %

Table 4.2 shows percentage of responses of teacher's perspective about technology, 55 % teachers were strongly agreed that they use different types of material while teaching. 4 % teachers were disagreeing that they actively search the web for relevant teaching resources. 21 % teachers were agreed that they teach students using multimedia.

Table No 4.3

Teachers perspective about Engineering ***(n = 214)***

S. No	Engineering	SD	D	N	A	SA
1	Students are taught by preparing learning tools and materials.	2 %	3 %	27 %	29 %	39 %
2	Students conduct experiments after lecture.	4 %	8 %	24 %	26 %	38 %
3	Teacher deliver lecture with demonstrations.	1 %	15 %	11 %	22 %	51 %

Table 4.3 shows percentage of responses of teacher's perspective about engineering, 39 % teachers were strongly agreed that students are taught by preparing learning tools and materials. 4 % teachers strongly disagreed that students conduct experiments after lecture. 22 % teachers were agreed that they deliver lecture with demonstrations.

Table No 4.4.

Teachers perspective about Mathematics ***(n = 214)***

S. No	Mathematics	SD	D	N	A	SA
1	It takes time in teaching mathematics in the class to carry out STEM Education.	2 %	3 %	26 %	45 %	24 %
2	Mathematics plays a vital role in STEM Education.	3 %	4 %	38 %	32 %	23 %
3	It is most appealing and fascinating subject in STEM Education.	12 %	12 %	20 %	29 %	27 %

Table 4.4 shows percentage of responses of teacher's perspective about mathematics, 45 % teachers were agreed that it takes time in teaching mathematics in the class to carry out STEM Education. 3 % teachers strongly disagreed that mathematics plays a vital role in STEM Education. 29 % teachers were agreed that most appealing and fascinating subject in STEM Education is mathematics.

Table No 4.5.

Prospects of teachers in implementing STEM Education (n = 214)

S. No	Prospects of teachers in implementing STEM Education	SD	D	N	A	SA
1	I am someone who really enjoys the uncertainties in my daily activities related to STEM.	1 %	14 %	20 %	36 %	29 %
2	I enjoy doing things related to STEM that are a little terrifying.	1 %	5 %	48 %	28 %	18 %
3	I look at challenging situations within STEM as opportunities to learn.	6 %	6 %	37 %	28 %	23 %
4	I support and explain things to individual students.	6 %	5 %	24 %	35 %	30 %
5	I invite other STEM teachers of different disciplines to coordinate with me on certain common topics.	5 %	7 %	19 %	30 %	39 %
6	Some teachers perceive that the integrated nature of STEM curriculum is a challenge.	8 %	9 %	32 %	30 %	21 %
7	Teachers perceive that the cross-curricular nature of STEM Education is beneficial to student learning.	4 %	8 %	36 %	27 %	25 %
8	Teachers believe STEM education is inherently motivating to students.	6 %	17 %	18 %	28 %	31 %

9	Culture of collaboration would Increase the viability of STEM programs.	3 %	8 %	34 %	31 %	24 %
10	Good quality of curriculum would enhance the likelihood of success of STEM initiatives.	7 %	8 %	33 %	32 %	20 %

Table 4.5 shows percentage of responses of "Prospects of teachers in implementing STEM Education", 36 % teachers were agreed that they are someone who really enjoys the uncertainties in their daily activities related to STEM. 28 % teachers were agreed that they enjoy doing things related to STEM that are a little terrifying. 6 % teachers strongly disagreed that they look at challenging situations within STEM as opportunities to learn. 35 % teachers are agreeing that they support and explain things to individual students. 39 % teachers were strongly agreed that they invite other STEM teachers of different disciplines to coordinate with them on certain common topics. 8 % teachers strongly disagrees that they perceive that the integrated nature of STEM curriculum is a challenge. 27 % teachers were agreed that cross-curricular nature of STEM Education is beneficial to student learning. 28 % teachers agreed that they believe "STEM education is inherently motivating to students". 8 % teachers are disagreeing that culture of collaboration would increase the viability of STEM programs. 32 % teachers are agreeing on the statement "good quality of curriculum would enhance the likelihood of success of STEM initiatives".

Table No 4.6.

Challenges while implementing STEM Education (n = 214)

S. No	Challenges while implementing STEM Education	SD	D	N	A	SA
1	Stem Teaching is affected by Lack of adequate training of teachers.	4 %	4 %	35 %	25 %	32 %
2	Teaching is affected by insufficient pedagogical support for teachers.	2%	8%	30%	32%	28 %
3	It is hard to hold the attention of students for long.	5 %	8 %	35 %	31 %	21 %
4	There is limitation of time.	4 %	11 %	25 %	41 %	19 %
5	There is restriction to cooperate with other professionals and experts that are related to STEM.	5 %	8 %	34 %	26 %	27 %
6	Lack of competency to prepare tools and materials needed in STEM.	3 %	7 %	34 %	27 %	29 %
7	The limitation of school facilities.	3 %	12 %	28 %	31 %	26 %
8	Insufficient number of computers for teaching.	4 %	8 %	29 %	27 %	32 %
9	Teachers are not familiar to compose STEM-based lesson plan.	4 %	10 %	17 %	45 %	24 %
10	Lack of interest of teachers towards STEM Education.	7 %	11 %	33 %	29 %	20 %

Table 4.6 shows percentage of responses of “Challenges while implementing STEM Education”, 32 % teachers were strongly agreed that Stem Teaching is affected by Lack of adequate training. 32 % teachers were agreed that they were affected by insufficient pedagogical support. 5 % teachers strongly disagreed that it is hard to hold the attention of students for long. 41 % teachers are agreeing that they there is limitation of time. 27 % teachers were strongly agreed that there is restriction to cooperate with other professionals and experts that are related to STEM. 3 % teachers strongly disagrees that there is lack of competency to prepare tools and materials needed in STEM. 31 % teachers were agreed that there is limitation of school facilities. 32 % teachers strongly agreed that they believe there are insufficient number of computers for teaching. 10 % teachers are disagreeing that they are not familiar to compose STEM-based lesson plan. 29 % teachers are agreeing on the statement “Lack of interest of teachers towards STEM Education”.

Table No 4.7.

Teachers perspective about science ***(n = 214)***

S. No	Science	Mean
1	Experiments are used in the classroom to explain the subject matter.	4.65
2	Scientific ideas are presented and explained to the whole class.	3.99
3	I use content from different subjects to explain scientific concepts.	3.72
	Total	**4.12**

Table 4.7 shows that the cumulative mean of "Teachers perspective about Science" is "4.12". This statement means that most of the teachers agreed to this. The highest mean score of this subscale of the statement "Experiments are used in the classroom to explain the subject matter" is "4.65" and the lowest mean score is "3.72" of the statement "I use content from different subjects to explain scientific concepts".

Table No 4.8.

Teachers perspective about Technology (n = 214)

S. No	Technology	Mean
1	Different types of materials (visual, audio, written) are used in teaching.	4.15
2	I actively search the web for relevant teaching resources.	3.67
3	Students are taught using multimedia.	3.56
	Total	**3.79**

Table 4.8 shows that the cumulative mean of "Teachers perspective about Technology" is "3.79". This statement means that most of the teachers agreed to these statements. The highest mean score of this subscale of the statement "Different types of materials (visual, audio, written) are used in teaching" is "4.15" and the lowest mean score is "3.56" of the statement "Students are taught using multimedia".

Table No 4.9.

Teachers perspective about Engineering ***(n = 214)***

S. No	Engineering	Mean
1	Students are taught by preparing learning tools and materials.	4
2	Students conduct experiments after lecture.	3.86
3	Teacher deliver lecture with demonstrations.	4.05
	Total	**3.97**

Table 4.9 shows that the cumulative mean of “Teachers perspective about Engineering” is “3.97”. This statement means that most of the teachers agreed to these statements. The highest mean score of this subscale of the statement “Teacher deliver lecture with demonstrations” is “4.05” and the lowest mean score is “3.86” of the statement “Students conduct experiments after lecture”.

Table No 4.10.

Teachers perspective about Mathematics ***(n = 214)***

S. No	Mathematics	Mean
1	It takes time in teaching mathematics in the class to carry out STEM Education.	3.87
2	Mathematics plays a vital role in STEM Education.	3.69
3	It is most appealing and fascinating subject in STEM Education.	4
	Total	**3.85**

Table 4.10 shows that the cumulative mean of "Teachers perspective about Mathematics" is "3.85". This statement means that most of the teachers agreed to this. The highest mean score of this subscale of the statement "It is most appealing and fascinating subject in STEM Education" is "4" and the lowest mean score is "3.69" of the statement "Mathematics plays a vital role in STEM Education".

Table No 4.11.

Prospects of teachers in implementing STEM Education ***(n = 214)***

S. No	Prospects of teachers in implementing STEM Education	Mean
1	I am someone who really enjoys the uncertainties in my daily activities related to STEM.	3.77
2	I enjoy doing things related to STEM that are a little terrifying.	3.93
3	I look at challenging situations within STEM as opportunities to learn.	3.69

4	I support and explain things to individual students.	3.78
5	I invite other STEM teachers of different disciplines to coordinate with me on certain common topics.	3.92
6	Some teachers perceive that the integrated nature of STEM curriculum is a challenge.	3.89
7	Teachers perceive that the cross-curricular nature of STEM Education is beneficial to student learning.	3.90
8	Teachers believe STEM education is inherently motivating to students.	3.62
9	Culture of collaboration would increase the viability of STEM programs.	3.66
10	Good quality of curriculum would enhance the likelihood of success of STEM initiatives.	4.12
	Total	**3.82**

Table 4.11 shows that the cumulative mean of “Prospects of teachers in implementing STEM Education” is “3.82” . The highest mean score of this subscale of the statement “Good quality of curriculum would enhance the likelihood of success of STEM initiatives” is “4.12” and the lowest mean score is “3.62” of the statement “Teachers believe STEM education is inherently motivating to students”.

Table No 4.12.

Challenges while implementing STEM Education (n = 214)

S. No	Challenges while implementing STEM Education	Mean
1	Stem Teaching is affected by Lack of adequate training of teachers.	4.67
2	Teaching is affected by insufficient pedagogical support for teachers.	3.73
3	It is hard to hold the attention of students for long.	3.86
4	There is limitation of time.	3.75
5	There is restriction to cooperate with other professionals and experts that are related to STEM.	3.62
6	Lack of competency to prepare tools and materials needed in STEM.	3.71
7	The limitation of school facilities.	4.12
8	Insufficient number of computers for teaching.	3.75
9	Teachers are not familiar to compose STEM-based lesson plan.	3.98
10	Lack of interest of teachers towards STEM Education.	3.65
	Total	**3.98**

Table 4.12 shows that the cumulative mean of “Challenges while implementing STEM Education” is “3.98”. This statement means that most of the teachers agreed to this statement . The highest mean score of this subscale of the statement “Stem Teaching is affected by Lack of adequate training of teachers” is “4.67” and the lowest mean score is “3.62” of the statement “There

is restriction to cooperate with other professionals and experts that are related to STEM".

4.2. QUALITATIVE ANALYSIS

Analysis of demographics shows that 50 teachers of primary level were interviewed with a 100 % response rate. All of the 50 teachers were females. These 50 teachers were divide into the 10 groups each consisting of 5 teachers. Majority of teachers were well experienced about the STEM Education.

This research is based on the process of investigating the teacher's prospects and challenges faced by them while implementing STEM Education. Teachers from 10 schools formed the population of the study. Purposive sampling was selected for the focus group discussion with the participants. Data was collected with the help of open – ended questions. Moreover, in a personal visit, the focus group discussion was conducted in the separate room to address and communicate with them in a peaceful environment.

Q.1. Which teaching skills are most required in implementing STEM curriculum?

Figure 4.1.

Word cloud for Teaching Skills required in implementing STEM Education

According to the teachers of primary level there are a lot of skills required for implementing STEM Education. Some teachers said that confidence is the first thing required for a teacher to implement STEM Education in the class rooms. Some teachers were agreed on the point of critical thinking, knowledge, teacher's devotion towards the subject matter because these are also the necessary skills.

Some of them said that behavior of students meant a lot in any classroom same as classroom environment is the same factor for the implementation of

STEM Education. Teachers says that they should have command on their subject both practically and theoretically. They said that the preparation of lectures is must before teaching and discipline should be maintained in the classrooms.

Q.2. Which challenges teachers faces while implementing STEM Education?

Figure 4.2.

Word cloud for Challenges Teachers faces while implementing STEM Education

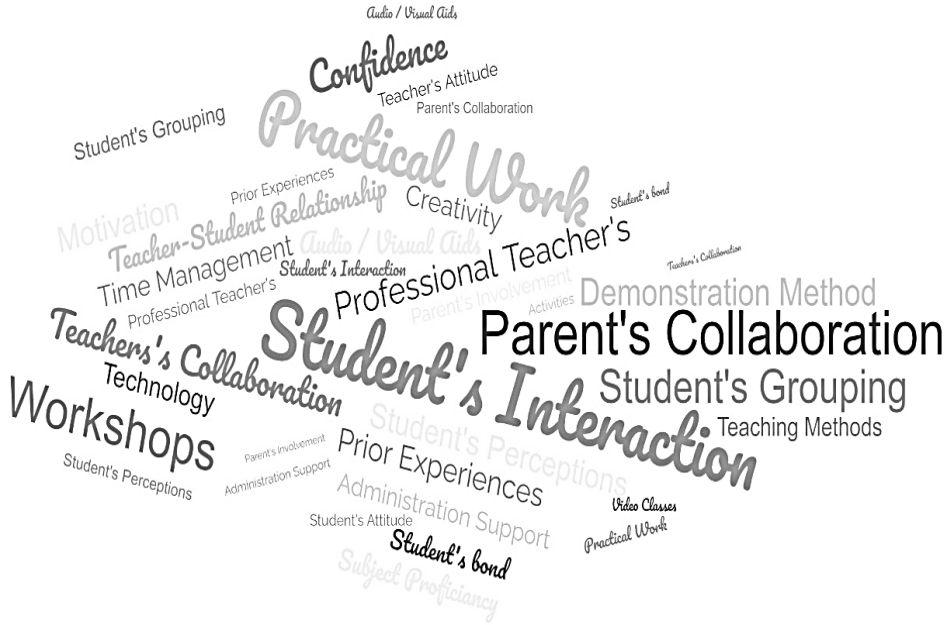
According to the teachers of primary level there are a lot of challenges faced by them while implementing the STEM Education. Teachers said that the most common challenge they are facing is the detailed knowledge of the subject as they don't have a relevant material and collaboration with other teachers teaching the same subject matter. Some of them have the issue in the infrastructure of the building, classroom environment and students strength.

Some have confidence issue as they cannot properly communicate with students or have lack of time which they cannot manage and leads to low confidence level. Student's motivation and their psychology is also a great challenge for the teachers though they can't do proper assessment of the students.

Q.3. What teachers feel that these will be the elements which will make the implementation of STEM Education easy in the classrooms?

Figure 4.3.

Word cloud for Teaching Elements required in implementing STEM Education



According to the teachers of primary level there are a lot of elements required which make the implementation of STEM Education easy in the classrooms. according to teachers first of all the students interaction and parents collaboration are the basic elements for implementation of stem education in the classroom as it becomes easy for the teachers with good collaboration with students, parents and teachers of the same subject matter.

Some of them were agreeing on the same point that teachers workshops, their training sessions are important in which they are taught about the practical works, teaching methods, grouping of the students for good implementation of STEM Education. Some teachers said that administrative support matters a lot. Some of them discussed about students bonding with them and their perceptions about the subject or self. Motivation also matters a lot. Different teaching methods should be used just as demonstration, audio – visual aids, etc.

CHAPTER 5

SUMMARY, FINDINGS, CONCLUSION, DISCUSSION AND RECOMENDATIONS

5.1. INTRODUCTION

This research intended to look for the teachers perspectives of primary level about the STEM Education. In this study the prospects and challenges of teachers faced while implementing STEM Education were seen. In this chapter the study's findings of two research questions are summarized. Furthermore this chapter also includes a summary of the study and a discussion of the results of the research questions. Finally, the conclusion was also drawn which was based on the findings and at the end some recommendations were made which were based on the conclusion of the study.

5.2. SUMMARY

STEM, an acronym for Science, Technology, Engineering, and Mathematics, is an innovative educational approach that emphasizes the teaching of design-centered knowledge and skills in these fields (Mustafa, 2018). The term "STEM" was coined in 2001, combining the initial letters of Science, Technology, Engineering, and Mathematics. Initially, it was introduced as SMET (Science, Mathematics, Engineering, and Technology), but this acronym had the potential to cause offense and was subsequently modified to STEM to avoid such issues (Breiner et al., 2012). It is an interdisciplinary learning method that is not limited to comprehensive solution to practical problems or teach separate knowledge of each subject as observed in case of traditional teaching. It develop

skills and help in building ideas through interlinking knowledge and experiences. Now a days using STEM education the students learn to establish with math, although they make researches as scientist and historians using different technologies which helps them in understanding the worldwide development and communicate about their needs so that they can obtain universal sustainability. Worldwide, with the development of the global economy, science and technology STEM education has become an important approach and policy for the beginning of the scientific and technological abilities and the modification in education and teaching.

The present research is to study the prospects and challenges of implementing STEM education at primary level. As the majority of the areas are reliant upon the STEM fields, it in a roundabout way assumes a huge part in the thriving of the economy. However, the researcher was interested to examine the perceptions of primary school teachers about STEM Education and explore the challenges which are faced by teachers while implementing STEM education at primary level. The mixed method research, exploratory Sequential design was used to conduct this study. STEM Education was the only variable of this research. The researcher delimited the study to teachers of private schools due to limited time and resources. The population of this research comprised of all teachers of private schools in Lahore. The sample drawn for the quantitative part was from the population which consists of 214 teachers (21% of the population) and for the qualitative part the sample was 50 teachers (5 % of the population) from the private schools of Lahore. The instrument used in this study was questionnaires and focus group discussions. There was no standardized and verified tool available for measuring the required variable, so the questionnaires

and focus group questions were developed by the researcher. In order to ensure the validity of the research instrument, questionnaires and focus group questions were got validated by the subject specialists. The reliability of the instrument was verified through pilot testing for a measure of its consistency and revealed high reliability as indicated by the Cronbach's Alpha = 0.868. For eliciting the information from teachers, the researcher used questionnaires and focus group discussions. One questionnaire was made consisting of 6 variables which includes total 32 items, different variables containing different number of items. The focus group discussion contains three questions which were open ended. The teacher's responses were recorded and analyzed by using descriptive statistics and word cloud generated.

Analysis of study indicated that it was difficult for teachers to implement STEM Education in schools. The qualitative findings of the study revealed that teachers highly value STEM Education, but they also reported various barriers hindering its implementation. These barriers included pedagogical challenges, curriculum challenges, structural challenges, concerns about students' readiness, concerns about assessments, and a lack of teacher support. Teachers emphasized the need for supports that would enhance their efforts to implement STEM Education effectively. These supports included opportunities for collaboration with peers, access to high-quality curriculum resources, district-level support, leveraging prior experiences, and participation in effective professional development programs. Implications suggest that the teachers who get proper training and guidance and support from the institute are able to go through STEM Education in the classrooms rather than those who are lacking training and institute support.

5.3. FINDINGS

5.3.1. Section 1 Quantitative part

The following findings were drawn from the analysis of quantitative data:

1. The result showed that in the concept of responses of teacher's perspective about science in STEM, 97 % teachers were on the point that experiments should be uses while delivering the lecture in classroom but 2 % teachers disagreed on this point. Only 3 % teachers were disagreeing on the point that they don't use scientific ideas to explain the data to whole class but on the other hand 58 % teachers were agreeing through this statement. At last, 55 % teachers were agreed that they use content from different subjects to explain scientific concepts but 8 % teachers were not agreed with this point (Table no: 4.1.).

2. Table no: 4.2. explains that in the concept of responses of teacher's perspective about technology in STEM, 77 % teachers said that they use different types of material like audio and visual aids while teaching but 11 % teachers do not uses these aids in the classroom. 7 % teachers were disagreeing that they actively search the web for relevant teaching resources but results showed that 64 % teachers uses the web for searching the relevant teaching resources. The last point of this concept showed that 51% teachers uses multimedia to teach their students but 20 % teachers don't do so.

3. The findings for the table no: 4.3. (Teacher's perspectives about engineering) showed that in the concept of responses of teacher's perspective about engineering in STEM, 68 % teachers prepare some learning tools and materials to teach their students but 5 % teachers don't prepare before the lecture. 12 % teachers said that students don't conduct experiments after lecture

but 64 % teachers said that their students perform experiments when taught. The last statement of the engineering education showed that 73 % teachers were agreed that they deliver lecture with demonstrations but on the other hand 16 % were disagreeing with this statement.

4. The result showed that in the concept of responses of teacher's perspective about mathematics in STEM, 69 % teachers said that it takes time in teaching mathematics in the class to carry out STEM Education but 5 % teachers refused that they don't need any time to teach mathematics in the classroom. 7 % teachers disagreed on the statement that mathematics plays a vital role in STEM Education but on the other side 55 % teachers said that mathematics plays an important role in STEM Education. The last statement of this concept showed that 56 % teachers were agreed that most appealing and fascinating subject in STEM Education is mathematics but 24 % teachers disagreed with this statement (Table no: 4.4.).

5. The outcomes of table no 4.5. Indicated that in the concept of responses of "Prospects of teachers in implementing STEM Education", 65 % teachers were agreed that they are someone who really enjoys the uncertainties in their daily activities related to STEM but 15 % teachers disagreed with this statement. 46 % teachers said that they enjoy doing things related to STEM that are a little terrifying but 6 % teachers do not enjoy doing things relevant to STEM which little were terrifying. 12 % teachers said that they do not look at challenging situations within STEM as opportunities to learn but 51% teachers look for the challenging situations within STEM as opportunities to learn. In the 4^{th} statement 65 % teachers were agreeing that they support and explain things to individual students but on the other hand 11 % teachers were disagreeing

through this statement. 69 % teachers said that they invite other STEM teachers of different disciplines to coordinate with them on certain common topics but 12 % teachers do not invite other STEM teachers. 17 % teachers disagreed with the statement that they perceive that the integrated nature of STEM curriculum is a challenge but on the other side 51 % teachers agreed on this statement. The 7th statement of this concept was that 52 % teachers said that cross-curricular nature of STEM Education is very beneficial to student learning but 12 % teachers said that this is not as such important for the students learning. 59 % teachers said that they believe "STEM education is inherently motivating to students" but 23 % rejected from this stamen that they do not believe in all this. The second last statement showed that 11 % teachers disagreed that culture of collaboration would increase the viability of STEM programs but 55 % teachers agreed on this statement. The last statement showed that 52 % teachers agreed on the statement "good quality of curriculum would enhance the likelihood of success of STEM initiatives" but 15 % teachers disagreed from the good quality of curriculum as a success of STEM initiatives.

6. The end result displayed by table no: 4.6. showed the responses of "Challenges while implementing STEM Education", 57 % teachers were agreed or strongly agreed that Stem Teaching is affected by Lack of adequate training while 8 % disagreed with this statement. 59 % teachers were agreed that they were affected by insufficient pedagogical support while 10 % teachers disagreed that they were affected by pedagogical support. In the third statement, 13 % teachers disagreed or strongly disagreed that it is hard to hold the attention of students for long but at the same time 52 % teachers agreed that it is not hard to hold students attention for a long time span. 60 % teachers are agreeing that

they there is limitation of time but 15% teachers do not agree on it. The fifth statement showed that 53 % teachers were agreed or strongly agreed that there is restriction to cooperate with other professionals and experts that are related to STEM at the same time but at the same time 13 % teachers disagreed with this statement. 10 % teachers disagrees or strongly disagrees that there is lack of competency to prepare tools and materials needed in STEM meanwhile 56% teachers agreed that there is lack of competency to prepare tools and materials needed in STEM Education. The seventh statement showed that 56 % teachers were agreed that there is limitation of school facilities and 15% teachers disagreed that there is limitation of school facilities. 59 % teachers agreed that they believe there are insufficient number of computers for teaching while 12 % teachers disagreed with this statement. 14 % teachers are disagreeing that they are not familiar to compose STEM-based lesson plan at the same time 69 % teachers were familiar how to compose the STEM – based lesson plans. The last statement showed that 50 % teachers are agreeing on the statement "Lack of interest of teachers towards STEM Education" while 18 % teachers are disagreeing with the given statement.

7. The cumulative mean of "Teachers perspective about Science" was "4.12". The highest mean score of this subscale of the statement "Experiments are used in the classroom to explain the subject matter" was "4.65". The lowest mean score of this subscale of the statement "I use content from different subjects to explain scientific concepts" was "3.72" (table no: 4.7).

8. The result showed that the cumulative mean of "Teachers perspective about Technology" was "3.79" approximately 3.80, though the highest mean score of this subscale of the statement "Different types of materials (visual,

audio, written) are used in teaching" was "4.15" and the lowest mean score of this subscale of the statement "Students are taught using multimedia" was "3.56" (table no: 4.8).

9. The result of table no: 4.9. showed that the cumulative mean of "Teachers perspective about Engineering" was "3.97". In this table the highest mean score was "4.05" of the statement "Teacher deliver lecture with demonstrations" and the lowest mean score was "3.86" of the statement "Students conduct experiments after lecture".

10. The outcome exhibited by table no: 4.10. was that the cumulative mean of "Teachers perspective about Mathematics" was "3.85". The highest mean score of this subscale of the statement "It is most appealing and fascinating subject in STEM Education" was "4.00" and the lowest mean score of this subscale of the statement "Mathematics plays a vital role in STEM Education" was "3.69".

11. Table no: 4.11. showed that the cumulative mean of "Prospects of teachers in implementing STEM Education" was "3.82" though the highest mean score of this subscale of the statement "Good quality of curriculum would enhance the likelihood of success of STEM initiatives" was "4.12" and the lowest mean score of this subscale of the statement "Teachers believe STEM education is inherently motivating to students" was "3.62".

12. The result of the last table of quantitative analysis (table no: 4.1.12) presented that the cumulative mean of "Challenges while implementing STEM Education" was "3.98". In this table no: 4.12 the highest mean score of this subscale of the statement "Stem Teaching is affected by Lack of adequate training of teachers" was "4.67" and the lowest mean score was "3.62" of the

statement “There is restriction to cooperate with other professionals and experts that are related to STEM” (table no: 4.12).

5.3.2. Section 2 Qualitative part

The following findings were drawn from the analysis of qualitative data:

13. The results of the figure no: 4.1. shows that there are a lot of skills required for implementing STEM Education. Some teachers said that confidence is the first thing required for a teacher to implement STEM Education. Some teachers were agreed on the point of critical thinking, knowledge, teacher’s devotion towards the subject matter. Some of them said that behavior of students meant a lot in any classroom same as classroom environment is the same factor for the implementation of STEM Education. Teachers said that they should have command on their subject both practically and theoretically. They said that the preparation of lectures is must before teaching and discipline should be maintained in the classrooms. These were the skills which were required by the teachers for the implementation of STEM Education in the classrooms.

14. Question no 2 / figure no: 4.2. exhibited the results of challenges faced by teachers while implementing the STEM Education. Teachers said that the most common challenge they are facing is the detailed knowledge of the subject as they don’t have a relevant material and collaboration with other teachers teaching the same subject matter. Some of them have the issue in the infrastructure of the building, classroom environment and students strength. Some have confidence issues as they cannot properly communicate with students or have lack of time. Student’s motivation and their psychology is also a great challenge for the teachers though they can’t do proper assessment of the students.

These were the challenges which were faced by the teachers while implementing STEM Education in the classrooms.

15. The results opted from figure no: 4.3., according to teachers first of all the students interaction and parents collaboration are the basic elements for implementation of stem education as it becomes easy for the teachers to have good collaboration with students, parents and teachers of the same subject matter. Some of them were agreeing on the same point that teachers workshops, their training sessions are important in which they were taught about the practical works, teaching methods, grouping of the students for good implementation of STEM Education. Some teachers said that administrative support matters a lot. Some of them discussed about students bonding with them and their perceptions about the subject or self. Motivation also matters a lot. Different teaching methods should be used just as demonstration, audio – visual aids, etc. These were the basic elements which teachers feel that these were the essentials which will make the implementation of STEM Education easy in the classrooms.

5.4. DISCUSSION

The purpose of the study was to determine the prospects and challenges of implementing STEM Education: teachers' perspectives at primary level. This study was purely mixed method both quantitative and qualitative. Exploratory sequential design was used for this study. The instrument used was self – made, questionnaire and focus group questions. The quantitative data was analyzed using descriptive statistics and qualitative data was analyzed using word cloud generator.

5.4.1. Section 1 Quantitative data

According to the findings of “teachers perspectives about science” mostly teachers said that they use content from different subjects to explain scientific concepts as it gives a vast learning for the students and concluded that they mostly uses different experiments while teaching. According to Suebsing & Nuangchalerm, 2021 teachers should aim to facilitate deep learning by connecting scientific concepts to real-life situations and encouraging students to actively engage in the learning process. When teaching science, it is crucial to help students understand not only the content but also the scientific process skills and attitudes towards learning. To achieve this integration, teachers can utilize inquiry-based learning methods in their science instruction, enabling students to explore and evaluate scientific concepts in a meaningful way.

Teachers play a crucial role in facilitating students' understanding of science in their daily lives and fostering problem-solving skills in science, mathematics, and technology. The quality of education, along with the integration of mathematics, technology, and innovative approaches, influences teachers' ability to cultivate positive attitudes towards learning (Nugroho et al., 2019). According to the findings no 2 and 8 (Teachers perspectives about technology) mostly teachers uses different types of materials like audio, visual and written. This helps students to learn easily as if one is not interested in listening he can only focus on the written material and same goes with them who are not interested in written data they can only listen to the teachers. Mostly teachers also uses web for searching the material relevant to their subjects to make the knowledge more reliable and interesting for the students and also uses multimedia but this

facility is not available in every school so some teachers said that they don't use such technologies.

The findings for "teachers perspective about engineering" showed that most of the teachers deliver the lectures by using demonstration methods which could be practical as well as it makes the students to give proper attention in the classroom and makes the learning easy and enjoy full for the students. Most of the teachers uses different tools and materials to make the lecture attractive and then ask the students to perform the experiments after the lecture which will help the teachers to know how good the students have learned the material / lecture.

The finding no: 4 and 10 showed that mathematics was the most fascinating subject in the STEM Education because it creates the interest in students and students are explained by using different shapes and colors according to their interest as well as this tis the most easiest subject in the STEM Education. Also mathematics plays an important role in our lives too.

According to the findings of "Prospects of teachers in implementing STEM Education" most of the teachers said that good quality of curriculum would enhance the likelihood of success of STEM Education because the knowledge always matter a lot either it is STEM or any other subject. The best the curriculum is the best the response of learning from the students will be. That's why it has the highest mean score in the table. According to Suebsing & Nuangchalerm, 2021, by incorporating STEM principles into the curriculum, teachers can provide students with a comprehensive education that connects various disciplines and promotes critical thinking, creativity, and collaboration.

This integration enables students to explore the interconnectedness of STEM fields and prepares them for future opportunities and challenges in an increasingly technologically advanced world.

The findings of “Challenges while implementing STEM Education” showed that training of teachers was the basic challenge through which STEM teaching is affected. The teachers said so because they are not guided properly how to teach the subject matter, don’t have proper or relevant experience about the subject matter, they are not taught to have a good collaboration with the partner teachers who are rich with the certain knowledge. To ensure the successful implementation of STEM education in schools, there is a need for greater clarity and emphasis on collaborative work (Bush et al., 2020) (Zakariya, 2020) (Permanasari et al., 2021). Time management was also a great challenge for the teachers as with less time they can’t deliver the whole lecture which leads the teachers towards lack of interest for STEM Education.

5.4.2. Section 2 Qualitative data

According to the finding no: 13 there are a lot of skills required for implementing STEM Education. Some teachers said that confidence is the first thing required for a teacher to implement STEM Education in the class rooms because less confidence make them confuse which leads to less attention towards students. Some teachers were agreed on the point of critical thinking as it is very important to do a better judgment or evaluation of the students. Teachers said that knowledge is also a necessary skill because it is a hallmark of a teaching profession without having a good knowledge they can’t teach the students with a good information. Teacher’s devotion was also a skill in which

they said that it is necessary because it passionate in whatever they are doing whether that it is a teaching or it leads towards an extra – curricular activities. Some of them said that behavior of students meant a lot in any classroom. They said so because if students are good – natured, easy to talk to, friendly and social, etc they could give a good response and make the teaching easy for them and if students are shy, staring, having tantrums and refuse the instruction, etc they will create problem in the classroom disturbing the other students as well as the teachers. Same as classroom environment is the same factor for the implementation of STEM Education because if the classroom environment is safe, respectful, welcoming and supportive of student learning it will make the implementation of STEM Education easy for teachers. According to Suebsing & Nuangchalerm, 2021, teachers play a crucial role as facilitators in helping students meet their educational needs and achieve success in their learning journey. They create an environment that encourages students to confront challenging situations, develop higher-order thinking skills, and actively engage in classroom activities. As a result, effective teachers must possess a deep understanding of both learning management strategies and the specific content they are teaching. By combining these essential elements, teachers can provide a comprehensive and impactful learning experience for their students. Teachers said that they should have command on their subject both practically and theoretically because some students are good at practical's and some are good at theory so it will be easy for both type of students to learn and easy for teachers as well. They said that the preparation of lectures is must before teaching because it will allow you to teach easily rather than to be confused every time if you don't have the understanding of the lecture. Discipline should be maintained in the classrooms. It doesn't

means to have students sit silently and listening to teachers it means to participate in a respectful manner so that others are not disturbed. If these distractions are removed from the classroom it will make STEM Education easy for the teachers.

The second finding of this part showed that, according to the teachers of primary level there are a lot of challenges faced by them while implementing the STEM Education. Teachers said that the most common challenge they are facing is the detailed knowledge of the subject because they are not guided in a proper manner or the books don't have appropriate or to the point information as required by the teachers. They also said that the reason behind not having a detailed knowledge is a poor collaboration with other teachers teaching the same subject matter as they don't share their knowledge with each other's. Some of them have the issue in the infrastructure of the building because if the building is small and students are more the classroom environment will become suffocated which will cause the slow learning of students which leads towards the more effort for teachers to teach. If the sitting space is not appropriate how a student will collaborate with teacher in a depressing environment. Sometimes, teachers unintentionally create controlled environments in their classrooms, separating science from real-life situations and neglecting to emphasize its social dimension. Teachers should strive to create dynamic and interactive learning environments (Suebsing & Nuangchalerm, 2021). Some have confidence issue which make them confuse which leads to less attention towards students and cannot properly communicate with students because of low confidence level. Low confidence can also be a reason of less time or bad management of the time according to the teachers. Student's motivation and their psychology is also a great challenge for the teachers because if their work will not be prioritized, goals will not be

settled, they will not be acknowledged on good behavior or completion of the given task they won't cooperate with teachers which will leads towards major challenge for them in the classrooms. Same as they will also not able to do proper assessments of the students as required by the administration or the parents. These are all the challenges which creates hurdles in implementing STEM Education in the classroom in an easy manner.

According to the third and last finding of this part there were a lot of elements required by the primary level teachers which make the implementation of STEM Education easy in the classrooms. According to teachers first of all the students interaction and parents collaboration are the basic elements for implementation of stem education in the classroom. As student's interaction is often considered a key to academic success, when the students will maintain a good connection with the teachers, the teachers are more likely to feel satisfied and get inspired to implement the STEM Education in the classrooms. Parent's collaboration at the same time is also important as it helps in supporting their children through their challenges and helps in improving the children's academic achievement, work habits and social skills which also helps teachers in the classroom to easily manage their students and concentrate on delivering a good knowledge. Many teachers emphasized the importance of workshops and training sessions for their professional development. They acknowledged that these opportunities were valuable for their growth and learning, allowing them to develop new teaching strategies, improve classroom management techniques, and stay updated with technological advancements. The teachers recognized that attending workshops and training sessions helped them enhance their instructional practices and effectively adapt to the evolving educational landscape. Teachers

said that practical work is also important because students have a good memory in learning verbally instead of cramming some knowledge. They said that teachers should use different teaching methods like project – based learning, cooperative learning and flipped classroom learning, etc as students feels good with different teaching methods and learn in proper manner. Some teachers said that students should be divided in the groups so that it could be easy for them to judge that which student have good learning memory and which student don't have. This will help them to easily communicate with the students and can easily implement STEM Education in the classrooms. Some teachers said that administrative support matters a lot as if administration let the teacher freely educate the students and respect their teaching style they would be more comfortable with it. To foster effective learning, it is essential to prioritize the development of essential learning skills. Teachers can achieve this by employing appropriate classroom management techniques that align with the interests of the students and the unique context of the class (Setiawan & Sugiyanto, 2020). Some of them discussed about students bonding with them and their perceptions about the subject or self as students bonding meant a lot. Motivation also matters a lot if teachers are motivated by the school heads they will give a good output. Some teachers said that they should use both audio and visual aids as students are attracted from both of these means of communication. These were all the elements which teachers thought that if they have to implement STEM Education easily in the classroom they have to follow them.

5.5. CONCLUSION

The present research is to study the prospects and challenges of implementing STEM education at primary level. Students and teachers must work together so that subjects are presented and understood in a manner that can be practiced in real-life in an integrated manner. To effectively implement STEM Education, teachers need a comprehensive understanding of aligning curricular standards, creating integrated assessments, and developing lessons that seamlessly combine the arts with STEM subjects while ensuring academic integrity. Exploring teachers' perspectives on adopting STEM teaching methods is essential to achieve this goal.

However, the researcher was interested to examine the perceptions of primary school teachers about STEM Education and explore the challenges which are faced by teachers while implementing STEM education at primary level. The mixed method research, exploratory Sequential design was used to conduct this study. STEM Education was the only variable of this research. The population of this research comprised of all teachers of private schools in Lahore. The sample drawn for the quantitative part was from the population which consists of 214 teachers (21% of the population) and for the qualitative part the sample was 50 teachers (5 % of the population) from the private schools of Lahore. The instrument used in this study was questionnaires and focus group discussions. There was no standardized and verified tool available for measuring the required variable, so the questionnaires and focus group questions were developed by the researcher. The teacher’s responses were recorded and analyzed by using descriptive statistics and word cloud generated.

Stohlmann, Moore and Roehrig (2012) found that teachers' passion for STEM education significantly influences their confidence and comfort in implementing the curriculum. Same as the finding no: 5 and finding no: 13 shows that good quality of curriculum would enhance the likelihood of success of STEM initiatives according to teachers. Teachers also said that confidence required for a teacher to implement STEM Education in the class rooms because less confidence make them confuse which leads to less attention towards students. According to a study by Park, Byun, Sim, Han & Baek, 2016, experienced teachers generally have a more positive perception of the importance of STEM Education compared to new teachers with 1 to 5 years of experience. This finding suggests that training sessions and pedagogical support are crucial for teachers to gain a solid understanding of STEM Education (Finding 6).

According to the other findings teachers said that they face pedagogical challenges, curriculum challenges, structural challenges, concerns about the students, time, knowledge and assessments of the students in implementing STEM Education. According to the study conducted by Margot and Kettler, the findings indicate that teachers recognize the need for fundamental shifts in classroom environments and teaching practices when implementing STEM pedagogy. Additionally, teachers believe that students may lack the necessary skills or motivation to succeed in STEM education or initiatives. These findings shed light on the complexities and obstacles that teachers face when incorporating STEM education into their classrooms. With respect to finding no 13, 14 and 15 teachers need collaboration with other teachers, parents and students, good quality of curriculum, district support, prior experiences and professional development. Further that study conducted by Margot and Kettler, highlighted

that teachers hold certain beliefs regarding the success of STEM initiatives. Lastly, they express the belief that well-organized and frequently available professional learning opportunities are essential for facilitating successful STEM initiatives.

In researchers opinion the study was important and worth consideration for teachers and students. In researcher opinion the research should also be done on higher level teachers and in public schools also. In her option STEM Education is the bests way to introduce the integrated knowledge through which students learning and academic behaviors are made better. Technology is most required at primary level because the internet and digital tools allows students to explore different subjects. It helps in connecting the classroom experience to the real world and adds a fun factor to learning. It helps students in reinforcing math, spelling, phonetic, and reading skills. As primary level students are at the stage when they are becoming creative and curious learners and if students are taught with proper integrated curriculum they will pursue to multidisciplinary or interdisciplinary education for their future career.

5.6. RECOMMENDATIONS

1. Workload adjustment may be done by school administration and lessen the number of periods from 5 - 6 to 3 - 4 periods so that teachers are able to adopt STEM pedagogy.

2. The curriculum may be revised and it may contain the STEM learning outcomes aligned with the achievement of STEM education.

3. The trainers may be hired in the schools to train the teachers regarding the implementation of STEM Education.

4. STEM Education informs not only STEM teaching but also the development of teaching materials such as textbooks so this may be considered.

5. Awareness seminars may be conducted to facilitate the teachers in understanding the concept of STEM education.

6. The study should be conducted on different population and at different levels.

7. STEM Education resources may be made available to all teachers in the classrooms by the school management.

8. Student's engagement should be made sure for better integration of STEM Education into teaching practices.

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APPENDIX: I

QUESTIONNAIRE

PROSPECTS AND CHALLENGES OF IMPLEMENTING STEM EDUCATION: TEACHERS' PERSPECTIVES AT PRIMARY LEVEL

Dear teachers, thank you for your assistance in collecting data for my research thesis which is being conducted for looking the prospects of teachers and challenges faced by them by implementing STEM Education at primary level in Lahore, Punjab. You are kindly requested to fill this questionnaire. It is assured that the information provided will be used for academic purpose only and will kept confidential. Your response will be highly appreciated.

DEMOGRAPHICS

Name: _____.

School Name: _____

Class:

□Below 1 □1 □2 □3 □4 □5

Age:

□20-30 □31-40 □41-50 □Over 50

Including this school year, how long have you been teaching (at any school)?

□Less than 1 year □1-3 year's □4-8 year's □9-15 years

SA* Strongly Agree **A*** Agree **N*** Neutral **D*** Disagree **SD*** Strongly Disagree

Sr.	STATEMENTS	SD	D	N	A	SA
A.	**Science**					
1.	Experiments are used in the classroom to explain the subject matter.					
2.	Scientific ideas are presented and explained to the whole class.					
3.	I use content from different subjects to explain scientific concepts.					
B.	**Technology**					
4.	Different types of materials (visual, audio, written) are used in teaching.					
5.	I actively search the web for relevant teaching resources.					
6.	Students are taught using multimedia.					

C. Engineering

7.	Students are taught by preparing learning tools and materials.					
8.	Students conduct experiments after lecture.					
9.	Teacher deliver lecture with demonstrations.					

D. Mathematics

10.	It takes time in teaching mathematics in the class to carry out STEM Education.					
11.	Mathematics plays a vital role in STEM Education.					
12.	It is most appealing and fascinating subject in STEM Education.					

E. Prospects in implementing STEM Education

13.	I am someone who really enjoys the uncertainties in my daily activities related to STEM.					
14.	I enjoy doing things related to STEM that are a little terrifying.					
15.	I look at challenging situations within STEM as opportunities to learn.					
16.	I support and explain things to individual students.					

17.	I invite other STEM teachers of different disciplines to coordinate with me on certain common topics.					
18.	Some teachers perceive that the integrated nature of STEM curriculum is a challenge.					
19.	Teachers perceive that the cross-curricular nature of STEM Education is beneficial to student learning.					
20.	Teachers believe STEM education is inherently motivating to students.					
21.	Culture of collaboration would increase the viability of STEM programs.					
22.	Good quality of curriculum would enhance the likelihood of success of STEM initiatives.					

F. Challenges while implementing STEM Education

23.	Stem Teaching is affected by Lack of adequate training of teachers.					
24.	Teaching is affected by insufficient pedagogical support for teachers.					

25.	It is hard to hold the attention of students for long.					
26.	There is limitation of time.					
27.	There is restriction to cooperate with other professionals and experts that are related to STEM.					
28.	Lack of competency to prepare tools and materials needed in STEM.					
29.	The limitation of school facilities.					
30.	Insufficient number of computers for teaching.					
31.	Teachers are not familiar to compose STEM-based lesson plan.					
32.	Lack of interest of teachers towards STEM Education.					

APPENDIX: II

LIST OF SCHOOLS

The list of the schools from where the data was collected for questionnaires is as follows: These all schools are Lahore based and are private schools.

Sr No.	Name of School
1.	Ahmed Public School
2.	Ali public School
3.	Al-Tahir Education School
4.	American Lyceum
5.	Bloom Field High School
6.	Bright Hall School System
7.	British Grammer School
8.	Dublin School of Learning
9.	Educators School
10.	Lahore Grammer Science School
11.	Lahore Public School

12.	Marching Bells School
13.	National Public Boys High School
14.	National Public Girls High School
15.	Oxford English School
16.	Qazi Apex Grammer School
17.	Sigma Foundation Boys School
18.	Sigma Foundation Girls School
19.	Sims School System
20.	Sweet Ways Boys School
21.	Sweet Ways Girls School
22.	The Beacon School
23.	The City School
24.	The Fajar School
25.	The Punjab School
26.	The Root School
27.	The Savy School
28.	The Smart School

29.	The Spirit School
30.	The Star School
31.	The Stem School

The list of the schools from where the data was collected for focus group is as follows: These all schools are Lahore based and are private schools.

1.	Bloom Field High School
2.	Dublin School of Learning
3.	Marching Bells School
4.	National Public Boys High School
5.	Sigma Foundation Girls School
6.	Sims School System
7.	Sweet Ways Boys School
8.	The City School
9.	The Savy School
10.	The Smart School

LAHORE COLLEGE FOR WOMEN UNIVERSITY

CERTIFICATE OF VALIDITY-RESEARCH TOOL

PROSPECTS AND CHALLENGES OF IMPLEMENTING STEM EDUCATION: TEACHERS' PERSPERCTIVES AT PRIMARY LEVEL

This is to certify that the questionnaire developed by the scholar towards her thesis has been accessed by me and I find it that it has been designed adequately to look for the perspectives of teachers regarding STEM Education.

It is considered that the research instrument; developed for the above title research, is according to the research objectives and research questions.

It assures adequate construct validity according to the purpose of the research and can be used for data collection by the researcher with fair amount of confidence.

Name: Dr. Tayyaba Batool

Designation: Assistant Professor.

University: Lahore College for Women University, Lahore.

Date: 30/9/2022

Signature:

Stamp: Assistant Professor, Lahore College For Women University, Lahore.

LAHORE COLLEGE FOR WOMEN UNIVERSITY

CERTIFICATE OF VALIDITY-RESEARCH TOOL

PROSPECTS AND CHALLENGES OF IMPLEMENTING STEM EDUCATION: TEACHERS' PERSPERCTIVES AT PRIMARY LEVEL

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It assures adequate construct validity according to the purpose of the research and can be used for data collection by the researcher with fair amount of confidence.

Name: Dr. Afifa Khanam

Designation: Assistant Professor

University: Lahore College for Women University

Date: 29-9-2022

Signature:

Stamp: Dr. Afifa Khanam
Incharge Faculty
Research & Evaluation Department
Institute of Education
Lahore College for Women University Lahore.

NATIONAL UNIVERSITY OF MODERN LANGUAGES
FACULTY OF SOCIAL SCIENCES
DEPARTMENT OF EDUCATION

ML.1-4/2021/Edu

Dated: 27th June 2022

To: Hajra Jameel
19 MPhil/Edu/S21

Subject: APPROVAL OF MPHIL THESIS TITLE AND SUPERVISOR

1. Reference to Letter No, ML.1-4/2021-Edu, dated 27-06-2022, the Competent Authority has approved the title and supervisor in 13th BASR meeting dtd 1st June 2022 on the recommendations of Faculty Board of Studies vide its meeting held on 12th April 2022.

   a. Supervisor's Name & Designation
      Dr Wajeeha Aurangzeb (Supervisor)
      Associate Professor
      Department of Education, NUML, Islamabad.
   b. Thesis Title
      Challenges and Prospects of Implementing STEM Education : Teachers' Perspectives at Primary Level

2. You may carry out research on the given topic under the guidance of your supervisor and submit the thesis for further evaluation within the stipulated time. It is to inform you that your thesis should be submit within described period by 31st December 2023 positively for further necessary action please. *(Timeline attached)*

3. As per policy of NUML, all MPhil/PhD thesis are to be run on Turnitin by QEC, NUML before being sent for evaluation. The university shall not take any responsibility for high similarity resulting due to thesis run from own sources.

4. Thesis is to be prepared strictly on NUML's format that can be taken from (Dr Saira Nudrat, Coordinator MPhil/PhD)

Telephone No: 051-9265100-110 Ext: 2094
E-mail: snudrat@numl.edu.pk

Dr. Wajeeha Shahi
Hea
Department of Educatic

Distribution:

Hajra Jameel (MPhil Scholar)

Dr. Wajeeha Aurangzeb (Thesis Supervisor)

full thesis

ORIGINALITY REPORT

5%	%	%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Hanoi National University Student Paper	1%
2	Submitted to Higher Education Commission Pakistan Student Paper	1%
3	Submitted to Swinburne University of Technology Student Paper	<1%
4	Submitted to University of Nebraska at Kearney Student Paper	<1%
5	Submitted to Victoria University Student Paper	<1%
6	Submitted to Segi University College Student Paper	<1%
7	Submitted to Kirikkale University Student Paper	<1%
8	Submitted to Lebanese American University Student Paper	<1%

9	Submitted to Fiji National University Student Paper	<1 %
10	Submitted to Universiti Teknologi MARA Student Paper	<1 %
11	Submitted to Liberty University Student Paper	<1 %
12	Submitted to University of Strathclyde Student Paper	<1 %
13	Submitted to Colorado State University, Global Campus Student Paper	<1 %
14	Submitted to Cyryx College, Maldives Student Paper	<1 %
15	Submitted to Chapman University Student Paper	<1 %
16	Submitted to Mahidol University Student Paper	<1 %
17	Submitted to Flinders University Student Paper	<1 %
18	Submitted to American College of Education Student Paper	<1 %
19	Submitted to Universiti Utara Malaysia Student Paper	<1 %
20	Submitted to University of Hertfordshire	

	Student Paper	<1%
21	Submitted to Assumption University Student Paper	<1%
22	Submitted to Submitted on 1686740141095 Student Paper	<1%
23	Submitted to Union Institute and University Student Paper	<1%
24	Submitted to Universiteit van Amsterdam Student Paper	<1%
25	Submitted to University of KwaZulu-Natal Student Paper	<1%
26	Submitted to British University In Dubai Student Paper	<1%
27	Submitted to Midlands State University Student Paper	<1%
28	Submitted to Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development Student Paper	<1%
29	Submitted to University of West Alabama Student Paper	<1%

Exclude quotes	Off	Exclude matches	< 8 words
Exclude bibliography	Off		