Impact of STEM's in the Secondary School Teaching Process

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ABSTRACT

In current modern era, the effectiveness of STEM education in the teaching and learning processes of teachers and students has a large area. Pakistan is in the early phases of incorporating STEM education into the teaching and learning process in developing countries around the world. The goal of this study was to talk about STEM education and the components that go into teaching and learning in general. This research was descriptive in nature, and quantitative data analysis were used. STEM integrated teaching and learning process development and advancement at the secondary school level. The populations of the study were all the teachers of secondary schools in three district of Baluchistan. Two hundred (200) secondary school teachers were randomly selected as a sample. The information was collected from secondary school teachers through a self-developed questionnaire. The researcher visited personally and given instructions to the teachers about filling of the questionnaire. SPSS tool was used to measure the frequency and percentage of analyzed data. The result of the study shows that there is a strong need for teachers to integrate the effectiveness of STEM and the classroom environment. The study found that education stakeholders should make it easier for teachers to make the most of STEM integrated training with the necessary resources and support teachers through training. The research may suggest that the Ministry of Education allocate funds to education department for the development and advancement of STEM integrated teaching learning process at secondary school level.

Keywords: *STEM Education, Teachers, Stakeholders, Teaching learning process and Secondary Schools*

Introduction

STEM education is an advanced methodology to education (Bissaker, 2014; Sanders, 2012) and has a wide range of features within the global education policy and reform landscape. STEM education represents an interdisciplinary approach that combines the four disciplines of science, technology, engineering and mathematics (Chesky & Wolfmeyer, 2015). This method not only talks the objectives of policy reform such as the provision of mathematics and subject skills but also emphasizes that it is no longer enough for current citizens to understand science and mathematics; knowledge should be combined with engineering and technology (Chesky & Wolfmeyer, 2015; Stehle & Peters-Burton, 2019; Margot & Kettler, 2019). Engineering design teaching is a project based method for integrating subjects requiring students to relate content knowledge to solve problems. STEM pedagogy is based on this. This encourages pupils to learn new concepts and enhance their thoughts (Mooney & Laubach, 2002).

STEM Education is characterized as a multidisciplinary in which severe academic principles are mixed with world learning in scenarios that build a relationship between school, public, work and the international business when pupils use science, technology, engineering and mathematics. STEM literacy and hence new economy competitiveness (Tsupros, Kohler, & Hallinen, 2009). Although many definitions of STEM education have been proposed (Bybee, 2013), it is generally accepted that both in concept and training STEM education deals with the integration of four disciplines (science, technology, engineering and mathematics) in different ways and levels (NAE, 2014). STEM education stresses the need to integrate theoretical knowledge to practical issues as a basis for integrating STEM topics into education (Margot & Kettler, 2019). STEM education offers high quality science and technology education and appropriate information to understand scientific, technological and traditional relationships through the integration of S-T-E-M disciplines (Bybee, 2013).

It also gives crucial digital skills to students and soft capabilities such as problem solving, creative thinking and critical thinking of a nation's workforce for economic success (Wong, Dillon, & King, 2016; Barragán, Sánchez, Corujo Vélez, Palacios-Rodríguez, & Román, 2020). Future citizens are increasingly needed to learn about STEM education concerns and to understand socio scientific technical linkages and how they are used to solve real challenges. Modern citizens should employ their acquired school based knowledge for the solution of development challenges including pollution from the environment, unforeseen climate occurrences, water and energy depletion and social and political conflicts. STEM education not only prepares exceptional students from the STEM, it also improves their innovative capacity an ever more crucial ability to openly embrace change and create the future responsibly. Modern citizens can achieve sustainable lifestyles through these sophisticated abilities: advocating human rights, gender impartiality and a culture that is not in contradiction with peace and violence; enhancing traditional diversity and fostering culture's influence to ecological development.

The era of science, technology, engineering and mathematics (STEM) is a topic emerging in modern education (Wang, 2012). This period was mainly aimed at increasing competence and competitiveness between schools and the curriculum. The concept has implications for diversified sectors such as workforce development and national security. However, the term is specifically used in educational policy and curriculum solutions (Mujtaba & Reiss, 2015). With the global economy and the rapid development of science and technology, STEM education has become an important strategy and approach for cultivating scientific and technological innovation talent and education and teaching reform in various states around the world. In particular, the concept of STEM education is still emerging in Pakistan, however as for other developed countries, the concept has gained significant advantages.

Pakistan like other developing countries in the world is at an early stage in terms of the importance and integration of STEM in the teaching process in educational institutions. Undoubtedly, there are many obstacles to the integration of STEM into the teaching process in instructive institutes. A variety of factors affect the importance of STEM in institutions to be effective in the teaching process. STEM is incredibly significant to instructors and students, since it offers both students and teachers exceptional learning opportunities (Imaad, Wajid, Chaudhary, & Sarwar, 2016). STEM improves active learning and makes students feel accountable in and out of school.

The teacher can easily plan and prepare lessons, design procedures and material such as content, content delivery and make it easy to share resources with students based on their experience and knowledge (Misseyanni, Papadopoulou, Marouli, & Lytras, 2018).

In scientific education, there is a general consensus among researchers that one of the places to represent STEM in the education system and eliminate its negative image is to attract young minds interested in research in the first grades especially at secondary level (Swarat, Ortony, & Revelle, 2012). STEM is a revised traditional method to the teaching of science, technology, engineering and mathematics that merges the four subjects into one single meta-discipline (Fioriello, 2010). Sadly most of STEM's training is routine for both integration and superior alternative teaching practices (Marrero, Gunning, & Germain-Williams, 2014).

Integrated STEM training is focused on students and has shown the capacity to enhance material and encourage problematic resolution and better thinking skills (Stohlmann, Moore, & Roehrig, 2012). STEM Education is aimed at understanding how science, technology, engineering and mathematics utilize this information to identify concerns, gain new understanding, use knowledge on connected issues and grasp STEM humanitarian research, design, analysis and differentiation. Our physical, intellectual and cultural life is shaped worldwide by the STEM fields.

STEM intends to teach science and math students not only to ensure their success in exams but also to improve the world. Ackermann (2007) said that the design application is not designed to reach a model in which it exists and is traditional but to imagine and then implement everything that is not in our reality. STEM integrates active and co-operative learning with verbal communication and problem solving and scientific knowledge and math, engineering structure and technological application in research, design, testing and applicable concepts (Reyes, 2012).

Successful STEM training coincides with good teaching applications and is for many teachers a subject of confusion (Breiner, Harkness, Johnson, & Koehler, 2012). Several educators are ready to begin STEM training. Wilson (2011) reports that it is an effective guide that enables students to become actively involved in science, mathematics and ingenuity and to broaden their knowledge about STEM jobs while teaching their lives better. The students therefore consistently deepen the fundamental STEM principles and concepts shared in science, technology, engineering and mathematics. STEM's participation was encouraged with five influences: interest and engagement (Zhao, Carini, & Kuh, 2004), expertise and support, attitudes and behaviour, professional knowledge and learning and knowledge of material (Swarat et al., 2012).

Aims and Research Objectives

This research helps to increase the success of STEM education in Pakistani curricula and concepts including materials provided to students at different stages and relevant to Pakistani STEM education teachers. Thus we try to increase practical activities in such education. The study highlighted the role of the Pakistani Ministry of Education in this area and what needs to be done to expand STEM education and identified the benefits of STEM for educational outcomes in Pakistan. The purpose of this study was to investigate a number of small scale STEM instruction cases, the prominent features of integrated STEM teaching and their variations. As we approached this work, we were aware of the different concepts of what integrated STEM teaching is or can be, while also intending to understand how integrated STEM teaching can be implemented in the context of real classrooms and teachers' integrated STEM conceptualization in practice. In contrast, we sought to base our work on empirical evidence for teachers' actual application of STEM lessons. The aim of the study is to examine the current literature on teachers' perceptions of STEM capacity development. This study seeks to recognize what is known about teachers' beliefs about the development of STEM talent. The following objectives were used to identify the effectiveness of STEM education in teaching and find out the factors affecting on STEM education.

Review of Literature

STEM is a relatively new trend for emerging countries in the educational process and in the classroom. For teachers and administrators effective utilization of this area is also tough in the classroom. Olivarez (2012), which aims to investigate the impacts of science, technology, engineering and mathematics (STEM) on academic achievement. The result was higher than the STEM based academic group in the STEM based group in all outcomes, as STEM teachers used project based learning, collaborative learning and hands on learning that had a positive impact on students' achievement in math and subjects and reading.

Wang (2012) reveals that teacher perception of STEM integration and how to integrate them into STEM capacities in educational practices. As a result of the research, the integration of the STEM approach was achieved not by the number of integrated curricula in the classroom but by the use of engineering design by students to find the maximum number of scientific or mathematical knowledge solutions to problems. Carter's (2013) work was developed to reach a consensus on the features of an integrated STEM approach. A team of experts was selected based on their knowledge of the integrated STEM approach. The study found inconsistencies

between goals and outcomes in both the existing literature and the STEM oriented literature in the business training programs of private companies and institutions. This work identified the features of STEM's integrated curriculum approach.

In STEM education, the mix of socio cultural theory discussion and skills becomes a revolutionary way of learning. Developing a critical consciousness that supports the meaningful development of a connected world (Reynaga-Peña, Sandoval-Ríos, Torres-Frías, López-Suero, Lozano Garza, 2018). (Fernandez-Limón, Fernandez-Cárdenas, & Galindo) In addition, this learning technique is a marginalization reduction mechanism so that communities can benefit from both monetary and social benefits and thus measure well-being and quality of life by using other approaches such as a skills approach (Sherman, 2016). STEM education is not only a content based learning but also an integrated teaching approach that can help develop skills and lifelong learning skills (Pickering, Yuen, & Wang, 2016).

Educational institutions generally have a responsibility to train, prepare and educate students in a broad sense that is to provide the means necessary for the ever changing conditions of society and companies (Sierra-Gómez, 2013). The existing competencies required for the 21st century have created changes in existing education systems. However, the model of some schools is still outdated and in order to be a learning facilitator according to constructivist theories (Khan, 2017), teachers need to re-evaluate figures as a transmitter of knowledge.

STEM programmes identify challenges that have to be coordinated and employed productively to resolve issues in science, technology, engineering, and mathematics. During the STEM period, students are exposed to numerous scientific and engineering activities due to the various challenges which can be resolved. Therefore learning is practicable as well as a way for students and society to solve existing problems. This is a constructive strategy to train the next generation of STEM experts to make our society competitive (Sakar, 2016).

Continuously transformational learning and discussion and increasingly recognized the role of formal and non-formal contexts to educate instructors on STEM issue have influenced the evolution of pedagogy in teaching subjects of STEM (Fernández-Limón, Fernández-Cárdenas, & Gómez Galindo, 2018). Undoubtedly, it is important for the future of the country that not all individuals are directed to STEM areas and those who are interested in these areas are directed to STEM areas. The training of upcoming STEM teachers and the support of teachers who see them affecting into places within STEM schools will require a systematic attitude to professional improvement (Wilson, 2013).

Research Methodology

Considering the nature of the problem description method, it was considered appropriate for the job. The research was of a quantitative nature and used quantitative analysis of the data in this study. To assess the effectiveness of STEM in effective teaching learning process at secondary school level in Balochistan, this study therefore adopted a quantitative research design to investigate this phenomenon and used a self-developed research tool to collect the

data. Quantitative research design which is objective in nature provides a broad description of the problem. Therefore, in a situation where research was needed, what factors predicted STEM in the effective teaching process in secondary schools adopted by teachers were objective rather than concentrating partiality by exploring the 'how' and 'why' phenomenon happens, so a quantitative research study design was adopted. The populations of the study were all the teachers of secondary schools in Balochistan. Sampling of the study was taken from the target population. Two hundred (200) teachers of secondary school were the population of the study. The researcher visited personally and given instructions to the teachers about filling of the questionnaire. SPSS tool was used to measure the frequency and percentage of analyzed data.

Results

Empirical evidence is needed to support each theory. Thus, there is no tool other than statistics to investigate the overall effect in a sample database. Therefore, descriptive and resulting statistics were applied using the Social Sciences Statistical Package (SPSS, v.22) to analyze the data in line with the objectives of the study. Finally, conclusions and discussions were made taking into account the findings.

Table 1

Frequency distribution of demographic details of the participants

Demographic Variables	**Values**
Gender	
Male	130 (65%)
Female	70 (35%)
Teaching Experience	
Less than 2 years	42 (21%)
2-5 years	66 (33%)
6-10 years	52 (26%)
Above 10 years	40 (20%)
Education	
B.A/B.Sc.	135 (67.5%)
M.A/M.Sc. and above	65 (32.5%)
Material Status	
Single	92 (46%)
Married	108 (54%)

The results in Table 1 show that 65% of teachers are male and 35% of teachers are female. Thus, there was almost equal representation of each gender in this study. In addition, four levels were addressed in the questionnaire to observe the impact of teaching experience on research variables. The results showed that 21% of the teachers belonged to the group of teaching experience for less than 2 years, and the largest part among all fields of practice, i.e. 33% of the teachers were in the group of 2-5 years of teaching experience. 26% of teachers have 6-10 years of teaching experience and 20% have 10 years or more. As for the marital status of the teachers 46% of the total teachers are single and 54% of the teachers are married.

Questionnaire Data Analysis

Effectiveness of STEM in teaching learning process and factors affecting on STEM at secondary school level were presented in the following Table 2.

Data show that 82% believe that more educated teachers use STEM education more effectively in teaching learning process. Data depicts that 81% of teachers agreed that STEM education can be integrated into teaching learning process. Seventy two percent they think that STEM knowledge of secondary school teachers has a greater impact on teaching learning process. Teachers differed on whether teachers' gender differences affected the use of STEM education in teaching learning process. Eighty five percent of teachers believe that old teaching methods should be replaced with new STEM teaching aids to improve teaching and learning process. Majority of 77% teachers' attitudes affect the successful integration of STEM education into teaching. A majority of 82% teachers agreed that the government has a decent policy to improve the current state of STEM education in secondary schools. 95% teaches are disagreed with the school education department's support for teachers in STEM education training sessions. Overall data shows that 68.1% teachers are agreed that factors influencing on STEM education in teaching learning process.

Discussion and Conclusion

The effectiveness of STEM in all fields affects the importance and integration of STEM in teacher learning and causes various changes in societies with 21st century capabilities. According to the findings of this survey, secondary school instructors are concerned about the importance of STEM education and its integration into the classroom environment. Secondary school instructors, on the other hand, confront numerous hurdles and obstacles in implementing STEM education in the classroom. Implementing STEM education in the classroom necessitates a significant amount of government funding. According to the report, teachers with a higher degree are more interested in STEM education. They can make more effective use of STEM education. It is determined that teacher gender differences have a significant impact on the effectiveness of STEM instruction in the classroom.

According to the study's findings, the government should replace old teaching techniques with new technologies and technological approaches that play a positive role in secondary school instructors' teaching for greater student learning. It has also been observed that the school education department encourages STEM education for teachers and supports instructors through STEM education trainings. This finding is consistent with several other investigations (Eroglu & Bektas, 2016; Kzlay, 2016; Siew, Amir, & Chong, 2015). Before establishing a STEM curriculum, Yashar, Baker, Robinson-Kurpius, Krause, and Roberts (2006) emphasised the significance of assessing teachers' attitudes and preferences about engineering design. It was observed that STEM consciousness of school leaders is quite high. It was determined from the administrators that it would embody information, be productive, provide interest and motivation, help students 'cognitive, emotional and psychomotor skills and broaden students' horizons. A small number of them said they had no awareness and would not make any involvement. This finding is consistent with the responses given by teachers and supports the view that STEM education will further pay to students. Numerous

studies supporting this discovery are available in the literature (Capraro, & Morgan, 2013; Chang, Ku, Yu, Wu, Kuo, 2015). Most administrators said that STEM was possible and that it had an impact on courses and some administrators said it was not.

Recommendations for further studies

The purpose of this study was to observe STEM integration perceptions and classroom experiences of secondary school science teachers. One necessary next step would be to conduct a study that would look at students' learning when applying a STEM integration lesson in a science room. A work that touches on student learning can provide a more comprehensive picture of how STEM integration can or may not help students learn in STEM subjects. Since problem solving is one of the main focus areas in STEM integration in addition to looking at STEM subjects, future research should examine students' problem solving skills and abilities when applying a STEM integration lesson in a science room. It is recommended that the government has an active role in the implementation of STEM education in secondary school education. The Ministry's education has an important role to play in allocating funds to the education department to promote STEM education at secondary school level. Senior teachers have the ability to see that they will play a leading role in providing STEM educational materials from school funds. Teachers must believe that all students can help from STEM training. As students originate to experience achievement in their classrooms, they will be encouraged to continue STEM activities. Finally, by hiring five secondary school teachers, this work builds a STEM integration model for secondary science teachers. However, the number of participants in this study may be a limitation. In order to test the STEM integration model of secondary school teachers, it is important to examine whether the study which has more participants can represent STEM integration concepts and classroom experiences of secondary school teachers in general. In addition, there is no information in this study on primary school teachers' perceptions and STEM integration classroom experiences.

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