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Secondary School Teachers' Perception on Stem Integrated Education: A Analysis

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ABSTRACT

American President Barak Obama said on Third Annual White House Science Fair in April 2013 that "One of the things that I've been focused on as President is how we create an all-hands-on-deck approach to science, technology, engineering, and math… We need to make this a priority to train an army of new teachers in these subject areas and to make sure that all of us as a country are lifting up these subjects for the respect that they deserve". This single part of the speech pinpoint the importance of STEM education and backbone of it "Teachers". Cross disciplinary appeals have manifold appeals. Same is in the field of school education. Once it's a time, science has a leading role at elementary and secondary school level. Then engineering becomes the prominent figure but when technology comes, all other fields merged in it. Mathematics remains the mother of all subjects. Now, it's a time of STEM integrated education where STEM is the acronym of Science, Technology, Engineering and Mathematics. STEM is not only confined to an acronym but also leads to the change of education system or approach from the root level. Presented study aimed at to highlight the secondary school teachers' perception regarding STEM education. As it's a new and novel concept, so not a big deal of work has done on it. So, existing literature was analyzed systematically to highlight the importance, challenges and future of STEM education which surely helpful to introduce in the developing countries like Pakistan. Presented study just focused on the perception and viewpoints of teachers who are working at elementary or secondary school level. Study concluded that teachers are highly motivated and confident for the STEM integrated education but there is a dire need to give suitable policy for this new trend of education which ultimately addresses the issues of curriculum, pedagogy, learning environment, career developers and future of the learners.

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1. Introduction

STEM (Science. Technology, Engineering and Mathematics) is a growing area of study and research world widely. It was a time, when nations have the policy and mind to focus on the science education. Later it comes a time of engineering but it's a very short span. Meanwhile, technology shows its strength and everywhere there is a strong functioning and operation observe. Life is the name of change and especially in the field of education and research. Now, the new era is of STEM and there is a dire need to work on it. Developed countries are changing their mode of education and they are focusing on STEM based education. The major focus of STEM education is at elementary and secondary level. These countries work on the STEM in different domains: STEM based education and STEM integrated education. For such purposes, literate workers of STEM are produced or trying to produce. Literate workers of STEM can be defined in the following terms:

i. A STEM literate should have the mindfulness on the different domains and characters of STEM subjects, according to need of the present and future society needs.
ii. Should have the adequate basic and fundamental Knowledge and concepts on each subject of STEM based education.
iii. Should have the necessary application smoothness level for STEM subjects (i.e. s/he have the capacity and ability to analytically assess the content and news reports based on engineering and science works; can handle and have the sense to resolve the troubleshooting of the technology; as well as have the analytical power to perform and solve the different basic and advance level mathematical operations.

It is estimation that there are 2.4 million unfilled jobs for STEM graduates only in USA (National Science Board, 2012). The word STEM is derived from the word "stem" which means "root". According to Gulgan (2017), STEM is not merely an acronym; it is an approach towards the transformation of theoretical knowledge of learners into practice based on STEM integrated knowledge. It is an application of academic knowledge which is targeted by a degree on the prosperous way of innovation and discoveries. Sadaive in 2018 opined that keep in mind, STEM basically is an attitude towards the constructive maintenance of continuous education system; it's never ever be considered as something new teaching method, or technique or even a model. It is easier to write and implement different activities for different disciplines in the constructive education approach whereas every activity is not used in STEM. There are some differences as well as similarities in teacher's profiles using the STEM and constructive education approach. STEM education approach has aimed at individual learners' learning that s/he have to know the basic usage of the information and communication technology (ICT) as well as have the interests and keen to integrate the ICT with science, engineering and mathematics. Here, the role of the STEM teachers enhanced many times and they should generally represent the role model for transferring and providing appropriate concepts and skills. Wong further added in 2018 that STEM literate workers can be very helpful at elementary and secondary school level, as they with the help of STEM teachers, integrate the STEM based curriculum in the regular curriculum and teachers with their pedagogy make this difficult task an easy opportunity.

Chamberlin and Pereira in 2017 strongly talked about the importance of STEM education and said that STEM is not the joining of four different fields i.e. Science, Technology, Engineering and Mathematics but it is more to it. It is prime focus is on bringing the theoretical knowledge of the learners towards the practical knowledge of the real world. It has the applications of inter and intra curriculum as well as pedagogy. As a result, STEM can change the concept that a learner of elementary or secondary certificate holder don't have only theoretical knowledge but also have practical knowledge and have the practical power to help the economy of the nation through his/her innovations or

discoveries (Gomes and Albret, 2013). Christenson (2011) summarized that STEM education fundamentally based on following six (06) standards of constructive and continuous education approach:

i. Science and Mathematics based content inclusion in education system
ii. Pedagogy should be learner centered
iii. Lesson planning focus on the encouraging and interesting contexts
iv. Inclusion of fundamental designing of engineering and its challenges.
v. Trial and error based learning
vi. Inclusion of real world challenges in focus with cross-curricular integration

Man is the greatest creation of Allah Almighty. He has manifold appealing mind and heart which can be observed in the form of talent. Each and every man where have some specific characteristics which are known as talent, at the same time, man has many common characteristics which are known as potential of man. With the help of potential man can leads towards the talent too. In 2011, Ganges said that man with the help of his abilities can perform wonders. But these wonders need some practice. Theory provides to students till secondary school level education and this theory comes to practice after secondary school certification. But now it's the need that learners should practice the theory while learning the theory. Ganges further added that shifting of knowledge from theory to practice; there is a dire need of catalyst. This catalyst, here, may know as school where learners put the theory in practice and give results in the shape of inventions and discoveries. Interpersonal skills may also be considered as catalyst, as it works in the form of confidence or perfection. Learning environment may also be taken as catalyst as it changes the man genetically. In learning environment, the key role is of teachers as their role as catalyst, firstly identify the hidden talent among learners, in second stage, they polish the hidden talent of students and in the next stage they motivate and guide the learner who produces the results in the form of invention or discovery.

Lessing *et al* (2016) mentioned that there is a perception among teachers that while shifting to STEM education; they need to change their pedagogy. This perception is not totally wrong as well as it is also not fully right. Teaching profession is the name to adopt continuous change in their pedagogy as curriculum changes very rapidly as per the needs and requirements of the present and future real world needs. So, it can be said that yes teachers has to change their pedagogy but it does not required fundamentals changes. Teachers' role and pedagogy will be more easiest in STEM integrated Education. As practical work can lessen the workload of the teachers and instructional work take more time and energy of the teachers.

McMullin and Reeve (2014), further classify it that teachers' has many responsibilities while they are in the school or class. One of them is designing of instructions to achieve the set goals for the learners. Delivery of lectures is another responsibility with an objective that students' interest and motivation level don't break. Then, there come the number of positive attitude of the teachers. With the help of only this characteristic, wonders were happened, wonders are happening and wonders can happen. With the help of STEM integrated education, teachers can produce scientists, engineers, technologists, mathematicians, educationists and researchers at early stage like elementary or secondary school level. Asghar et al (2012) told that some teachers have concerns about STEM pedagogy as different practical work by varied learners can diversified the objective of the subject or content. There is another group of teachers who take as a challenge the STEM integrated curriculum as well as perceive the STEM integrated curriculum as Heraclius task for the curriculum developers and setters as well as for policy makers.

Scot (2012) explained that STEM integrated education was firstly introduced at school level by Korea. But study shows that teachers were not properly trained as they didn't have manuals. School administration and management were not satisfied as they don't have enough resources. Assessment and evaluation was difficult as curriculum objectives were not matching the overall objectives of the program. Policy makers failed to create the interest if the parents as STEM program weaken to highlight the job area for the learners. There are also some issues on the learners' level too as they are not fully motivated and interested in the program.

Now the question rises, how STEM education or STEM integrated education can impart at elementary and secondary level and especially in the developing countries like Pakistan? Is there any major change in pedagogy? How learners can be motivated and their interest created in the STEM education program? There are many questions on curriculum, management, administration, policy makers, teachers, learners, and career developers too. But the presented study was only aimed at to focus on teachers and learners. Following research objectives were set and try to answer them in this study to achieve the aim of the study to review existing literature on STEM education in context of teachers' views and to highlight perspective of teachers regarding the STEM education through using existing literature.

2. Research Design

In order to review of literature researcher applied second source of data collection. Researcher searched, located and summarized the existing literature on the teachers' perception on STEM education and analyzed the exiting literature on thematic analysis basis in specific reference to achieve the aim of the study. As the field of the study if not novel, then surely being a new. Existing literature is very limited, especially in the context of developing countries and pinned at Pakistan level. Overall, seventy (74) different research articles and research studies were collected after the search online. Later they are categorized at according to the themes. Action research and survey research were the basic focus of the study. Study further filtered while analyzing the methodologies of the existing literate.

3. Data Analysis and Presentation

Under the light of information obtained from articles, reports and papers purely based on action research and survey research. Systematically, themes were investigated according to qualitative findings which were formed and order to provide easy interpretations. Themes were set as per the aim and need of the study. Table 1 shows the selected publications by type for the underlying study:

Table 1: Selected Publications by type

Type	No. of Studies	Percentage
HEC, Pakistan recognized International Journals	7	9.5%
HEC, Pakistan recognized National Journals	6	8.1%
Impact Factor Journals	2	2.7%
IEEE, Journals	3	4.05%
Scopus Index Journals	11	14.86%
ISI Index Journals	5	7.1%
Conference Papers	9	12%
Thomson Reuters Index Journals	2	2.7%
Web Science Index Journals	2	2.7%

DOAJ Index Journals	1	1.35%
PubMed Index Journals	1	1.35%
ESCI Index Journals	1	1.35%
Document Lexis Index Journals	1	1.35%
Copernicus Index Journals	1	1.35%
Plus Index Journals	1	1.35%
Nature Index Journals	1	1.35%
Social Sciences Index Journals	2	2.7%
Sciences Index Journals	2	2.7%
SSCI Index Journals	1	1.35%
OAJI Index Journals	1	1.35%
Other	8	10.8%
Web Sources	6	8.1%

Collected literature was taken into scope of this study was sorted according to features and their publication years. Interpretations and analyses were made in tabulated form.

Table 2: Teachers' Perception on STEM Education

Study Research Design	Findings	Author/s
Study was quantitative by nature. Teachers' motivation and confidence level were measured by pre and post professional development tests.	Observable difference in the form of positive change in the confidence level from pre to post professional development tests. At the same motivation level was consistently enhance. Teachers' self-efficacy remains constant. A strong relationship was observed between learning instructions and STEM based curriculum.	Nadelson et al. (2012)
A survey study was conducted to analyze the Pedagogy of STEM integrated education. Study was quantitative by nature and correlations were measured of different variables.	Teachers' pedagogy is average and their level of satisfaction and motivation is at comfort level at institutions. STEM education is in transition age and needs more work to reach at a justifiable stage, according to a big group of teachers.	Park et al. (2016)
A mix method research by nature and survey approach was adopted to identify the beliefs and perceptions regarding STEM Program. OLS regression was found.	Majority of teachers' belief that STEM education program is the need of the hour but time management and financial issues are big hurdles. Teachers' percept that need support from government and policy makers for the STEM graduates.	Park et al. (2017)
Another quantitative study which descriptive by nature and aimed at to highlight the different pedagogical issues. MANOVA was applied to found the results.	All four components (Science, engineering, technology and mathematics) are equally important. But technology is the core need and engineering is at the far end. A strong relationship was found between technology and science as well as between Engineering and Mathematics.	Smith et al. (2015
A mix method approach based study was designed.	A big group of teachers are not aware of the program and even not know about STEM Program. Teachers'	Srikoom et al.

Descriptive statistics and ANOVA was applied on quantitative data and Interpretive technique was applied on qualitative data.	perception on the STEM education has not shown significant level of interest by the teachers. Qualitative data shows that teachers have the enthusiasm for the new started program of STEM and have a good confidence level.	(2017)

Table 2 shows that learning standard and Perception about STEM is improved. Link between STEM and Education standard has been increased. Observable difference is found in the form of positive change in the confidence level from pre to post professional development tests. At the same motivation level was consistently enhance. Teachers' self-efficacy remains constant. A strong relationship was observed between learning instructions and STEM based curriculum (Nedelson et al, 2012). Teachers' pedagogy is average and their level of satisfaction and motivation is at comfort level at institutions. STEM education is in transition age and needs more work to reach at a justifiable stage, according to a big group of teachers (Part et al, 2016). Majority of teachers have belief that STEM education program is the need of the hour but time management and financial issues are big hurdles. Teachers' percept that need support from government and policy makers for the STEM graduates (Park et al, 2017). All four components (Science, engineering, technology and mathematics) are equally important. But technology is the core need and engineering is at the far end. A strong relationship was found between technology and science as well as between Engineering and Mathematics (Smoth et al, 2015). A big group of teachers are not aware of the program and even not know about STEM Program. Teachers' perception on the STEM education has not shown significant level of interest by the teachers. Qualitative data shows that teachers have the enthusiasm for the new started program of STEM and have a good confidence level (Srikoom et al, 2017).

Table 3: Challenges in STEM Teaching

Study Research Design	Findings	Authors
A survey based study of teacher about challenges in STEM Education Teaching was conducted. Study was quantitative by nature.	Teachers believe they have the challenges in different ways like sources and resources, lack of manuals of the program, no or very few professional development programs for this new program. Such things decrease the level of confidence and motivation among teachers which results as lack of learners' positive change. Even a group of teachers shows lack of confidence to cope with the program.	Van Haneghan et al. (2015)
A case study based on the qualitative research design was set. STEM teachers' perception was determined. Collected data was analyzed by applying constant comparative method.	Engineering appears as the most challenging subject. Technology and science proves its worth with the help of technology and mathematics is considered as basic of all subjects and mother of STEM education. Teachers' belief is that STEM program is time and resource consuming. Students are at their early age and at this age practical without one to one correspondence and guidance is not possible.	Wang et al (2011)

Table 3 shows that teachers believe they faced many challenges in STEM education. They face challenges in teaching methods and curriculum activities about STEM. Teachers believe they have the challenges in different ways like sources and resources, lack of manuals of the program, no or very few professional development programs for this new program. Such things decrease the level of confidence and motivation among teachers which results as lack of learners' positive change. Even a group of teachers shows lack of confidence to cope with the program (Haneghan, et al. 2015). Engineering appears as the most challenging subject. Technology and science proves its worth with the help of

technology and mathematics is considered as basic of all subjects and mother of STEM education. Teachers' belief is that STEM program is time and resource consuming. Students are at their early age and at this age practical without one to one correspondence and guidance is not possible (Wang et al. 2011).

4. Conclusion and Discussion

STEM education is a growing concept of teaching. Not too much but much work has done so far. The presented study was based on systematic existing literature review based. Thematic analysis based results can be concluded in the form that over all learning standard of STEM education are improved as well as the perceptions on it are positive. The link between STEM and Education standard has been increased. At the same, motivation level was consistently enhanced among teachers. Teachers' self-efficacy remains constant. A strong relationship was observed between learning instructions and STEM based curriculum. As for as the pedagogy is concerned, teachers' pedagogy is at average level as well as satisfaction and motivation level is at comfort level at institutions. STEM education is in transition age and needs more work to reach at a justifiable stage, according to a big group of teachers. Majority of teachers have belief that STEM education program is the need of the hour but time management and financial issues are big hurdles. Teachers' percept that they need support from government and policy makers for the STEM graduates. All four components (Science, engineering, technology and mathematics) are equally important. But technology is the core need and engineering is at the far end. A strong relationship was found between technology and science as well as between Engineering and Mathematics. But there is also a big group of teachers, who are not aware of the program and even not know about STEM Program. At the same time, teachers have the enthusiasm for the new started program of STEM and have a good confidence level.

As for as the challenges of STEM education program are concerned, teachers believe they faced many challenges in STEM education. They face challenges in teaching methods and curriculum activities about STEM. Teachers believe they have the challenges in different ways like sources and resources, lack of manuals of the program, no or very few professional development programs for this new program. Such things decrease the level of confidence and motivation among teachers which results as lack of learners' positive change. Even a group of teachers shows lack of confidence to cope with the program. Engineering appears as the most challenging subject. Technology and science proves its worth with the help of technology and mathematics is considered as basic of all subjects and mother of STEM education. Teachers' belief is that STEM program is time and resource consuming. Students are at their early age and at this age practical without one to one correspondence and guidance is not possible.

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