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Secondary School Students' Perceptions about STEAM Education in Pakistan: A Gender Perspective

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Abstract

STEAM is an acronym of Science, Technology, Engineering, Arts and Mathematics, which focuses on developing the critical thinking and problem solving abilities in students and creates interest towards STEAM subjects. The purpose of this study was to determine the perceptions of secondary school students towards STEAM education in Pakistan. Using random sampling, 338 students were selected for data collection. Questionnaire was used as an instrumental tool for collection of data. IBM SPSS version 22.0 was utilised for analyzing the data. The outcomes of this research study stated that students of both genders in Pakistan have different perceptions about STEAM educational subjects; the tendency of both genders are similar towards the use of technology in education whereas other four subjects show dissimilarity between male and female. Study suggests the students to be active in participation of STEAM education and recommends teachers to keep up to date their students about STEAM by providing them a fair chance to perform STEAM based activities during academic activities so that students can enhance their analytical, cognitive and creative skills. Management should provide a suitable and healthy environment for STEAM education and to ensure the curriculum plan as per STEAM.

Keywords: *STEAM, education, Pakistan, perception, gender*

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Introductıon

STEAM Education is an approach to teach the students Science, Technology, Engineering, the Arts and Mathematics for guiding students towards effective learning. It opened new gateways of learning and bring new opportunities in industry for the students. Improvement problem solving skills in students is the key objective of STEAM so they can solve different problems more effectively and in an interesting way (Harshini et al., 2014).

Another aim of STEAM education to develop interest of the student's understanding in all subjects like science, technology, engineering, arts and mathematics combined and with the help of real world applications and solving the problems in working practically (Altan and Ercan, 2016), so that when they start their career they would be able to handle all the problems which they have learnt from this system of education.

In the Pakistan STEAM education is still at an initial stage. In the secondary level still they are focusing the traditional classroom practices are essentially focused on rote memorization and examination practice. The students who participated in this study were secondary level students (Grades 9 and 10) in Sindh province, most of whom were enrolled in the science group. While science and mathematics were already compulsory subjects in their curriculum.

In the classroom students experience the STEAM activities such as projects, coding, robotics, problems solving and art based experiments. At the end of these activities result focus the students' perceptions of STEAM were shaped mainly by their traditional experiences in science and mathematics, rather than integrated, hands-on learning activities. After this activities if students hold positive perception towards STEAM despite limited classroom experience, this reflect their potential willingness for educational reform but if their perceptions are neutral or negative, this signals the need to redesign curricula and teaching practices to provide more opportunities for STEAM integration.

Investigating students' perceptions at this stage is therefore crucial for understanding both the demand for STEAM education and the preparation of schools and teachers in Pakistan to implement it effectively. Maes (2010) also endorsed the concept of STEAM education and explained how it is helpful to grab the attention of students and develop their interest towards science and technology and its works to develop the critical thinking abilities in students. It is important here to clarify that Rhode Island School of Design (RISD) initiated the STEAM movement, which adopted by many other institutions at a very large scale around the globe MEST (2012), and Baek et al. (2011, 2012). Educators who are associated

with STEAM are capable of helping people to integrate STEM education with addition of arts for greater understanding of the real world, which makes the understanding of this better and closer to human nature. While working with STEAM about to follow a bright career involving this innovative education.

STEM + Art = STEAM

Major dissimilarity between these two systems STEM and STEAM is that the STEM education represents an approach, which focuses on problem solving skills and critical thinking among students, and while adding arts into this STEAM education add value of creative thinking into this, which makes it more powerful and effective in learning. Arts value addition in STEM education is helpful for the students because they can perform scientific things aesthetically better and attractively with the help of fine art, music and visual art. Sparking the creativity and imagination in students is one of the strengths of STEAM over STEM education. Some STEM supporters believe when we include art subjects it is far away from the other main subject. (Hetland& Winner, 2004; Liao, 2016) STEAM merges with art the purpose of students' engagement, creativity, problem solving skills and other cognitive benefits.

Many supporting educators of STEAM are the believers that arts should never be ignored or overlooked because they feels that arts adds value in learning experience with the help of creative learning. STEM and STEAM are not a very new addition to the education system it is just integration. Now these integrations in education and learning which resembles real life Susan Riley, Arts Integration Specialist (2012).

So concluding from the above discussion, we found that STEM and STEAM simply integrate, rather than just teaching the subjects, giving lessons these are integration of a combination of subjects with inquiry and project based while focusing on interdisciplinary learning. With STEAM, we are teaching skills the way they will be used in the workforce, and the real world. Bybee (2010) stated that STEM education has three main parts: improving students' way of thinking, technology usage and integration of principles of engineering into the education of the students. The objectives of the STEAM educational approach are to introduce the design and art in STEM. They also buoy up people to take interest in designing and creativity, motivating students towards art education.

Currently STEAM educators are not very well trained on the teaching methods of STEAM education process but they are sharing the goal of creating a more holistic educational experience than the one they believe STEAM in education developed the critical skills in students is needed to succeed in the current and future. STEAM education teaches critical

thinking, problem solving, collaborative learning, creativity and many other skills, which leads them to success in practical life.

This research focused on the perceptions of students' (Male/Female) and what is their tendency towards STEAM education and what they feel about every part of this education in secondary level school in Sindh province Pakistan and how it creates the ability of problem solving and develops critical thinking in students. With the help of STEAM, education students will improve their way of thinking and learning. This study shall be a contribution to facilitate and support all the students irrespective of gender and their limitations. And not only this it would be helpful to know which subject is in the priority of male or female students so curriculum can be designed according to their interest and their engagement towards that particular subject and what they feel about it. That is why this research is quite different from the previous ones and a good addition towards the world of education. Therefore, the main objective of the study is to get perceptions about STEAM education and what students' feel about the subjects, which are part of it.

This research focused on the perceptions of male and female students regarding STEAM education at the secondary level in Sindh, Pakistan. It aims to explore how students perceive the five elements of STEAM, their priorities, and their interests. Understanding these perceptions will help curriculum developers and educators design learning experiences that align with students' interests, encourage active engagement, and provide equitable opportunities. This makes the present study distinct from previous work and a valuable addition to the literature. The main objective of the study, therefore, is to examine students' perceptions of STEAM education and what they feel about the subjects that form part of it.

Literature Review

STEAM education used for improving the understanding between science, technology, engineering, art and mathematics areas. STEAM is STEM, which based with addition of art components into it. STEAM encourages students for learning and improve their skills. The main purpose of this study is to know the perception of students in STEAM education in secondary level schools in Sindh province Pakistan. And not only this it would be helpful to know which subject is in the priority of male or female students so curriculum can be designed according to their interest and their engagement towards that particular subject and what they feel about it. That is why this research is quite different from the previous ones and a good addition towards the world of education.

Empirical Studies

Moon (2020) conducted a case study intended to know about students' perceptions about implementing STEAM integration of K-8 students. Eight students selected as sample size of the study through a convenience sampling process. Data was collected by different instruments; questionnaire was used to know about the background and experience of participants in education, interview was used to have detailed and diversities in ideas among participants and also to help researcher to be able to centralize the themes from gathered data and research notes to document the behavior, settings and nonverbal communication of respondents. Seven themes generated through the gathered data and considered as seven different techniques in beginning towards implementing STEAM integration. Additionally, administrators and teachers also believed that implementing STEAM in teaching practice would have fruitful results. Moreover, study suggests implementing the STEAM system in educational sectors and explores the importance of its integration.

Bush, Cook, Edelen and Cox Jr. (2020) conducted a research in which they investigated the perceptions of students about STEAM, who are studying at elementary level. Respondents responded to the open-ended questionnaire, total 1572 participated in it, and thematic analysis done on in this research. Findings of this study related to STEAM evolution and progress not all the times STEAM produces the same quality and same pleasant experience. At high quality STEAM, inquiries generate numerous opportunities like they experience the scientific world by doing scientific experiments and they solve real life problems by mathematics. As results and discussion shows that STEAM education is providing better learning opportunities for the educators so it is suggested in this study that elementary educators are very acute and serious in the integration of STEAM initiatives so that should continue to be applied to schools around the globe.

Han and Kim (2019) conducted a study on development and application of STEAM educational programs to verify the cognition skills, attitude towards STEAM and the satisfaction level after application of STEAM. The study gets its data from 168 elementary school students of fifth and sixth grade. The development of an activity based STEAM program focused on a topic from science subject 'The Solar system and stars'. The results show that after application of the STEAM based program, as per the behavioral system of science the cognitive development level of students was improved and the attitude of students towards STEAM

education was positively significant. The study suggested implementing the STEAM system in elementary schools.

Ozkan, Topsakal (2017) examined the perception and opinion of students about STEAM related activities. Participants of this research were students of a school in Istanbul and they are studying in grade 7. For data collection, an open-ended questionnaire at the end learning and teaching process. After analysis of the data, it revealed that there was a relatively positive approach of students about STEAM but not all responses were positive, few students also have negative sentiments and feelings about it.

Either it is a general opinion that STEAM education has a great system of learning and activities are really meaningful and practical for the students but in many published literatures, we observed that with many positive views are getting negative opinions also. As far as my opinion is concerned, there must be something in between which is a disturbing element for the students or might be for the teachers also. There should be some researchers, which can identify those problems; due to those issues, students are having negative views and opinions about STEAM education.

Hero and Quigley (2016) conducted a study having the main objective to investigate a modern form of education in the shape of STEAM instruction in K-12 classrooms. The research intends to focus on presenting a viewpoint for higher education students and k-12 researchers to allow the incorporation of STEAM teaching in professional development activities in classrooms and in pre-service education. The researcher uses a second order narrative approach to explain three focused cases of educators enacting successful STEAM practices in classrooms. The study recommended a remixing educational notion of STEAM, and suggested changing the existing practices and offering new instructions focusing on the STEAM system.

Baran, Bilici, Mesutoglu, and Ocak (2016) conducted a research to find out the views of the students about a program named "Out of school STEM Education". Because recently Turkey has reformed their educational policies, so they fulfill the need of skills and knowledge with the help of STEM. So on 6th grade students from underprivileged areas, this program implemented. Data collected by activity forms filled by those students who participated in it. This study suggests that activities of STEM and their integration in the out of school programs may be helpful and supporting to those students who are living in underprivileged or disadvantaged areas so they can pursue their career in a better way because finding of this study also suggests that collaborative learning is more engaging leaning for the students. Therefore, for the better career and better engagements of the

students this system of education, a high support system and grants should give.

Jeon and Lee (2015) investigated the thinking of high school students about application and development of STEAM education, which based on system thinking. For the research purpose they utilized the 'ADBAS' model Lee, Park and Kim (2013). Students from 60 high schools participated in this study. Moreover, they concluded the results qualitatively and quantitatively to get better and accurate results and they concluded that skills of system thinking improved after when they got treatment.

Jeong and Kim (2015) research intended to implement the STEAM curriculum in K-12 education. There were two main motives of the study, first was to examining the influence of hands-on global climate change monitoring projects (GCCMP) with the curriculum based on six structured inventive thinking (SSIT) that aims to develop the content knowledge of STEAM and second was to know about the perception of students of middle school about STEAM subjects. The study conducted on 68 seventh grade students from middle school of Seoul, Korea with a quasi-experimental research design. The outcomes of this study found that the students who participated in activities /projects gained STEAM content knowledge and showed an appreciable perception of on STEAM subjects. In addition to this study also shows that the female students perceive more positively about STEAM education rather than male. Moreover, it suggests designing and developing activity-based projects focusing on STEAM education for middle school students.

Man, Hyun, Jeong, Geul, Beom and Jun (2014) conducted a research to get perception of elementary students after application of substitute STEAM program while focusing on their 6th grade and energy unit to their curriculum. For this purpose, the qualitative method of research applied and they observed the classes and recorded the notes about all the observations they got from the class. In addition, after STEAM classes students who attended these classes they evaluated with interviews and surveys. Moreover, the results were surprising that in the beginning, some students felt some difficulties and hurdles in creative thinking and other things related to this but most of the students found it because they found it easy and fun learning. Learners warmly welcomed the concept of using knowledge in their practical form, learning a variety of subjects together, creativity space in learning and most important thing they also learn the social skills with STEAM Education. So this is a kind of epistemological approach must be used by the educators to enhance the teaching learning process.

Methodology

Population

Population of the study is composed of (Male/Female) students from Sindh province who are studying in secondary classes.

Sample

The data collected from 338 students (Male/Female) who are studying at secondary level (9th and 10th) in Sindh province.

Data Analysis

In this study, data has been analyzed using statistical software that is SPSS.

Research Instrument

The survey utilized to estimate the perceptions of students' (Male/Female) students in secondary level school in Pakistan. The tool was designed to measure students' perceptions of each of the five constructs of STEAM (Science, Technology, Engineering, Arts, and Mathematics). The questionnaire comprised a total of 25 statements, with 5 statements under each construct (S, T, E, A, M). These statements were rated on a 5-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5).

- **S (Science):** Items under this construct measured students' interest, confidence, and attitudes toward learning science subjects.
- **T (Technology):** Items explored students' willingness to use technology, comfort level with digital tools, and their perception of technology as a learning aid.
- **E (Engineering):** Items assessed students' interest in engineering-related concepts, problem-solving through design, and their perception of engineering as a career path.
- **A (Arts):** Items captured students' appreciation of creativity, imagination, and integration of arts into learning.
- **M (Mathematics):** Items gauged students' engagement, enjoyment, and perceived importance of mathematics.

The instrument was adapted from existing STEAM-related perception scales and modified to suit the context of Pakistani secondary school students. Responses individually obtained from students' who are studying at secondary level (9th and 10th) school in Sindh province Pakistan. To ensure content validity, the questionnaire was reviewed by subject experts in education and educational research. Their feedback was incorporated to align the items with local classroom contexts.

Reliability Test

Reliability refers to the precision or accuracy of the measurement of the score and the stability of the test measure or protocol.

Table 1
Reliability Statistics

Variables	No. of Items	Cronbach's Alpha Test
S	5	0.846
T	5	0.936
E	5	0.943
A	5	0.946
M	5	0.931
Overall Model	25	0.791

Since the above Table1 shows the Cronbach's alpha for overall model reliability is 0.791, which indicates optimum level of internal consistency for our scale exists within this sample.

Findings

Table 1
Gender wise distribution of sample

Gender	Frequency	Percent
Male	178	52.7
Female	160	47.3
Total	338	100.0

Out of 338 respondents, 178 or 52.7percent of the respondents were male whereas 160 or 47.3% were female students.

Independent Sample t-test

To analyze that there is no difference in the average response of male and female respondents towards STEAM. Independent sample t-test was used to test the hypotheses. Our set of hypotheses are given below.

H_1: Male and female tendencies are similar towards subject Science, element of STEAM.

H_2: Male and female tendencies are similar towards subject Technology, element of STEAM.

H_3: Male and female tendencies are similar towards subject Engineering, element of STEAM.
H_4: Male and female tendencies are similar towards subject Arts, element of STEAM.
H_5: Male and female tendencies are similar towards subject Mathematics, element of STEAM.

Table 2
Group statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
S	Male	178	4.4247	.75603	.05667
	Female	160	3.6412	1.19750	.09467
T	Male	178	4.3449	.71899	.05389
	Female	160	4.3075	.86755	.06859
E	Male	178	3.3663	1.21096	.09077
	Female	160	2.6138	1.23454	.09760
A	Male	178	3.5404	1.31838	.09882
	Female	160	4.3888	1.05860	.08369
M	Male	178	3.9090	1.16096	.08702
	Female	160	4.1025	1.04370	.08251

Table 3
Output of Independent Samples Test for Gender wise statistics

Variable	F	Sig.	T	df	Sig(2-tailed	Mean difference	StD Error difference
S (Science)	12.45	0.001	7.30	262.72	0.000	0.800	0.110
T (Technology)	3.67	0.057	0.00	309.24	1.000	0.000	0.68
E (Engineering)	0.27	0.604	5.26	330.97	0.000	0.700	0.133
A (Art)	4.92	0.027	-3.19	328.34	0.002	-0.400	0.126
M (Mathematics)	0.46	0.497	-0.88	335.95	0.382	-0.100	0.114

Out of 338 respondents 160 are female having average S value 4.4 with standard deviation 1.19, Whereas 178 male respondents having average S value 3.6 with standard deviation 0.75, it shows male and female tendencies are not similar towards Science Subject. So, H_1 was rejected. Out of 338 respondents 178 male respondents having average T value 4.3 with standard deviation 0.71,whereas 160 are female having average T

value 4.3 with standard deviation 0.86,it shows that female tendencies are using technology equally and both have almost equal trend towards technology. So, H_2 was accepted.

Out of 338 respondents 178 male respondents having average E value 3.3 with standard deviation 1.21,whereas 160 are female having average E value 2.6 with standard deviation 1.23,it shows that male takes more interest in engineering than female. So, H_3 was rejected. Out of 338 respondents 178 male respondents having average A value 3.9 with standard deviation 1.3, whereas 160 are female having average A value 4.3 with standard deviation 1.0,it shows that male doesn't take interest in Art as compared to female whereas female are having more interest in Arts. So, H_4 was rejected. Out of 338 respondents 178 male respondents having average M value 3.9 with standard deviation 1.1 ,whereas 160 are female having average M value 4.0 with standard deviation 1.0,it shows that female takes more interest in Mathematics than male and female take active part in Mathematics. So, H_5 was rejected.

Table 2

Interpretation Summary

Hypothesis	Variable	Result (SPSS-based Decision)	Interpretation
H1	Science (S)	Reject H_0	Significant gender difference — Females show higher tendency toward Science.
H2	Technology (T)	Fail to Reject H_0	No significant gender difference — both have equal tendency toward Technology.
H3	Engineering (E)	Reject H_0	Significant difference — Males show more interest in Engineering.
H4	Arts (A)	Reject H_0	Significant difference — Females show more interest in Arts.
H5	Mathematics (M)	Fail to Reject H_0	No significant gender difference in Mathematics.

Discussion

Outcomes of the study indicated that males are more interested in science than females as the same finding was supported by the study of Oliver & Simpson (1985) proving that females have less science interest. In technology male and female tendencies were found similar showing the consistency with different studies (Parka & Kim, 2014; Azhar & Parsaud, 2012; Auter, 2007) which posits that students are the early adopters of technology. In addition to this, engineering got more importance from males as compared to females; the similar result were concluded by Schreudersa, Mannonb and Rutherfordc (2008) that males are having high comfort level with engineering but it never means that a female can't go with engineering; they might lack their interest in engineering due to societal norms or self-satisfaction with career. Moreover, in the arts, female tendency was greater than male as one of the study conducted by Stina, (2013) reported that females showed a higher level of association with arts and as far as mathematics is concerned, males found it more affectionate than females. The consistency with this result was observed in study conducted by Grandy (1994) with the conclusion that most probably boys are more enthusiastic and interested in mathematics. These results suggest that while technology has become a neutral ground for both genders, traditional perceptions and interests still shape how students engage with other STEAM subjects.

Conclusion

The study intended to examine the similarity in male and female tendencies related to all five elements of STEAM. The finding concluded that male and female tendencies are similar towards the technology element of STEAM whereas it was found non-similar with other four elements; science, engineering, arts and mathematics. Results show the comparable mean among all five elements of STEAM.

Based on these findings, the following recommendations are made: Both male and female students should be encouraged to actively participate in all elements of STEAM education, as balanced exposure can enhance their problem-solving, creativity, and critical thinking skills. Teachers should design classroom activities that make science, engineering, and mathematics more engaging for female students, while also integrating arts-based learning approaches that appeal to male students. This will help reduce gender-based disparities in subject preferences. Institutions should provide equal opportunities and resources for male and female students to participate in STEAM activities. A supportive environment with hands-on projects, coding, robotics, and

creative arts will help bridge gaps in subject-specific interests. Curriculum reforms should focus on integrating STEAM subjects in a balanced way, ensuring that no subject is treated as gender-specific. Interdisciplinary learning should highlight how science, technology, engineering, arts, and mathematics complement one another in real-world problem solving.

Further studies should explore how cultural, social, and school-related factors influence gendered perceptions of STEAM. Replicating this study with diverse samples, contexts, and methodologies will provide deeper insights into how to promote inclusive STEAM education in Pakistan.

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