

# The Effects of Stem Centre Education on Students' Attitude towards Science, Mathematics, Technology and Engineering

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**Abstract:** This study was conducted to find out the effects of STEM centre education on grade 11 students' attitude towards science, mathematics, technology and engineering. In the study, 44 students within the STEM centre (treated group) were compared with 67 students out of the STEM centre (untreated group in public school). This paper applies both quantitative and qualitative research approaches. The data was collected through questionnaires and semi-structured interviews and the data from questionnaires were analysed using mean, percentage and chi-square with an Integrated Statistical Software Package (STATA) version 14.2. The findings of chi-square and mean values indicated that students in STEM centre were significantly good participants in science and mathematics subjects, had better attitude and confidence in doing activities related to science, mathematics, technology and engineering. In addition, the study proved that the treated students were interested in the occupations related to engineering and technology than untreated students. The interview results also supported the above findings. Students in the STEM centre stated that the program is effective in their learning and helps them to develop their skills, increases their interest in the profession of science, mathematics, technology and engineering. This implies that STEM centre education affects students' attitude positively. Thus, the study recommended that STEM centre education must be promoted in developing countries like Ethiopia to increase students' attitude in STEM-related careers.

**Keywords:** STEM centre education, Students' attitude.

## 1. INTRODUCTION

Recently, different countries have a great deal of interest to introduce innovation and fast growth using science and technology as they want to be benefited from globalization and knowledge-based economy and to tackle the challenges they face from globalization. Moreover, the government of each country believes that science education provides

good standards for its people and leads to cultural development. To succeed in the new information-based and highly technological society, students need to develop their capabilities in STEM. To develop science and technology, first it requires the development of science and mathematics education. However, the performance of African students in mathematics and science

is persistently lower than international averages (Ismail, 2018). In Sub-Saharan Africa, the number of students graduated with STEM-related degrees is very low (JA Africa, 2018). In developing countries like Ethiopia, students' performance in science and mathematics is very low (Muleta & Garoma, 2016; Beyessa, 2014). To alleviate/at least to minimize such problem, it is suggested that developing countries must first find the causes of those problems (Gödek, 2004).

Taking the abovementioned problems into account and considering the advantages of science and mathematics education, Ministry of Education in Ethiopia prioritize Science, Technology, Engineering and Mathematics (STEM) education in its education system (MOE, 2020). Within these field of Ministry of education (MOE), thus, works harder, to make its students problem-solver, creative and skillful using these field of studies (MOE, 2020). This enables the new graduate engineers to foster poverty reduction in their country. Ethiopia also believes that Transforming STEM for Innovation purpose has potential impact to speed up the nation's economic competitiveness. STEM education not only addresses the demand for scientists and engineers, but also helps to create a

responsible and goal-oriented citizen. Hence, to be competent in the global economy, stressing on STEM education values is very important (MOE, 2020). Also, strengthening the sector will enable the country's dedication to shift industry-led economy effectively. Therefore, to realize the efficient and effective economic shift in a short time, having students who have a good interest in STEM is very important.

Intent Research findings indicate that choosing a STEM major and achievement of students is directly influenced by intent (Wasike et al., 2013; Wang, 2013). Baran et al. (2016a) also find out that students' perceptions about STEM activities are critical to have good improvement in the area. Positive perception and ability in science of their peers also contribute significant role to students' choice to major in STEM disciplines (Caspi et al., 2019) and increasing students' interest in STEM disciplines would lead them to pursue STEM careers (Biceret al., 2015). Thus, motivating students to focus on science and mathematics starting from primary and secondary education is very important to create well-qualified professionals in Science, Mathematics Technology and Engineering areas (Christine, 2016).

Bahir Dar University (BDU) STEM center is one of the educational programs that prepares primary and secondary school students for college and graduate study in the fields of science, technology, engineering, and mathematics (BDU, 2014). Bahir Dar University STEM Center is found in Bahir Dar city, Ethiopia. This center was established a laboratory center called Bahir Dar STEM Incubation Laboratory Center in July, 2014. Its purpose is to conduct trainings and do projects both in the summer season and in the whole academic year. A total of 13 million ETB, which is funded by Mr. Mark Gelfand and Family Charitable Trust, was invested to construct the laboratory and fulfill laboratory equipment and furniture. Currently, there are 201 talented/gifted students who are attending the training in this center. These students are selected from all public and private secondary schools (grade 9-10) and higher education preparatory schools (grade 11-12) found in Bahir Dar City. The training includes STEM laboratory practices, life skills, teamwork, field exercises, games with funny approaches of science, site visits related to STEM like Bahir Dar Maritime Academy and College of Agriculture and Environmental Sciences of Bahir Dar University. In addition, the STEM center

encourages students to have inquisitive mind, develop their logical skills and foster their collaboration skills.

This laboratory center also provides different services for grades 9-12 students (BDU, 2020). These include making students do laboratory work in subjects like physics, chemistry, biology, mathematics, ICT and electronics, encouraging students develop project works in different fields of interest and giving summer training programs for outreach program (talented students) and math camp program. It also gives trainings for special/gifted students like life skills trainings, computer programming trainings. Preparing competition programs among students on Science, Mathematics and Engineering, science and technology club activities, teachers training programs on science simulation software, GeoGebra dynamical Mathematics Software, Multism and or Circuit Maker and individual-based digital library, internet and computer services for the digital library, are also the other tasks the STEM center does. Therefore, this study was aimed to investigate the effect of the STEM center education on students' attitude about science, technology, engineering and mathematics in the case of Bahir Dar University STEM centre students.

## 2. MATERIALS AND METHODS

### 2.1. Sampling Techniques

This study was conducted to test the effect of STEM centre education on students' attitude towards sciences, technology, and engineering and mathematics. To investigate the effects of the STEM centre education on students' attitude towards sciences, technology, and engineering and mathematics, 44 students within the STEM program (treated group) were compared with 67 students out of the program (untreated group). In this study, purposive sampling technique was applied to select schools where as students in each school were selected by using simple sampling to give equal chance for each individual.

### 2.2. Data Collection Instruments

This paper only applies primary data sources to get the required information for this study. A questionnaire prepared based on Likert Scale ranged from 1-5 ((1 = Strongly Disagree (SD), 2 = Disagree(D), 3 = Neutral(N), 4=Agree(A) and 5 = Strongly Agree (SA)) was used to collect data. The questionnaires were given to both groups of students (treated and untreated groups) to find out their attitude on science, mathematics, science and technology and engineering. In addition, semi-structured

interview was employed to STEM center students to investigate their opinions about their future STEM career.

### 2.3. Data Processing and Analysis

The data collected through questionnaire were coded, edited and entered into STATA (Statistical analysis software) for further statistical analysis. Accordingly, descriptive statistics such as mean and percentage were used. Chi-square test was also employed to see whether or not there is a significant perception difference between treated and untreated groups. To analyse the results about the perception of students towards science, mathematics, technology and engineering, rating scales (1 = Strongly Disagree (SD), 2 = Disagree(D), 3 = Neutral(N), 4=Agree(A) and 5 = Strongly Agree (SA)) were used. To determine the intervals of these ratings, Likert scale, according to Vichea( 2015) was taken as an appropriate way to put the intervals within five points as  $(5-1)/5 = 0.8$ . Based on this interval, the average rating of 5 to 4.20 rated as Strongly agree, 4.19 to 3.4 as agree, 3.39 to 2.6 as neutral, 2.59 to 1.8 as disagree and 1.79 to 1 as strongly disagree.

### **3. Results And Discussions**

#### **3.1. Comparison between treated and untreated students' attitude about science**

The results in table 1 indicate that 93.18% from the treated group and 52.22% from untreated group of students believed that they had better participation in science (Mean for treated=4.25, Mean for untreated= 3.52 with p-value=0.000). When we see the interest of students about science, 97.73% from treated and 76.12% from untreated students like science and the mean value for treated and untreated students' interest in science was 4.77 and 4.02 respectively with p-value 0.01. Similarly, from the treated group 15.91% and from untreated group 54.23% students believed that they can't do a good job with science (Mean for treated=1.72, Mean for untreated= 3.37 with p-value=0.000).

The results revealed that significantly most treated students believed that they had better participation in science, they can do good jobs with science and had better interest in science than untreated students. This result is in line with (Means et al., 2016) which shows STEM high schools increase students' interest in a science career and

(Jessica et al., 2017) shows STEM programs can be one way to help students maintain their motivation in science.

**Table 1. Result for comparison between treated and untreated students' attitude about science**

|   |   | Group     | SD<br>by % | D<br>by % | N<br>by % | A<br>by % | SA<br>by % | Mean | Pvalue |
|---|---|-----------|------------|-----------|-----------|-----------|------------|------|--------|
| 1 | I have good participation in science subjects                             | Untreated | 3(4.48)    | 11(16.42) | 18(26.87) | 18(26.87) | 17(25.37)  | 3.52 | 0.     |
|   |   | Treated   | 0(0.00)    | 0(0.00)   | 3(6.82)   | 27(61.36) | 14(31.82)  | 4.25 |        |
| 2 | I like science subjects   | Untreated | 4(5.97)    | 7(10.45)  | 5(7.46)   | 18(26.87) | 33(49.25)  | 4.03 | 0.01   |
|   |   | Treated   | 0(0.00)    | 0(0.00)   | 1(2.27)   | 8(18.18)  | 35(79.55)  | 4.77 |        |
| 3 | I expect to use science when I get out of school.                         | Untreated | 1(1.49)    | 10(14.93) | 9(13.43)  | 29(43.28) | 18(26.87)  | 3.79 | 0.016  |
|   |   | Treated   | 0(0.00)    | 0(0.00)   | 9(20.45)  | 14(31.82) | 21(47.7)   | 4.27 |        |
| 4 | Knowing science will help me earn a living.                               | Untreated | 1(1.49)    | 4(5.97)   | 4(5.97)   | 14(20.90) | 44(65.67)  | 4.43 | 0.816  |
|   |   | Treated   | 0(0.00)    | 1(2.27)   | 3(6.82)   | 10(22.73) | 30(68.18)  | 4.56 |        |
| 5 | I will need science for my future work.                                   | Untreated | 1(1.49)    | 0(0.00)   | 4(5.97)   | 19(28.36) | 43(64.18)  | 4.55 | 0.795  |
|   |   | Treated   | 0(0.00)    | 0(0.0)    | 2(4.55%)  | 11(25.00) | 31(70.45)  | 4.65 |        |
| 6 | I enjoy participating in science-related activities                       | Untreated | 2(2.99)    | 3(4.48%)  | 3(4.4)    | 30(44.78) | 29(43.28)  | 4.20 | 0.228  |
|   |   | Treated   | 0(0.00)    | 0(0.00)   | 3(65.82)  | 15(34.09) | 26(59.09)  | 4.52 |        |
| 7 | I can handle most subjects well, but I cannot do a good job with science. | Untreated | 9(13.43)   | 8(11.94)  | 13(19.40) | 23(34.33) | 14(20.90)  | 3.37 | 0      |
|   |   | Treated   | 28(63.64)  | 8(18.18)  | 1(2.27)   | 6(13.64)  | 1(2.27)    | 1.72 |        |

### 3.2. Comparison between treated and untreated students' attitude about mathematics

The results in table 2 revealed that 97.72% from treated group and 40.30% from untreated group of students enjoy learning mathematics (p-value=0.00) also, 90.91% from treated group and 51.22% from untreated group of students enjoy solving mathematics (p-value=0.00). From the treated group 77.28% and from untreated group 32.84% of students believed that they were good in mathematics (p-value=0.00). Similarly, for all treated students'

mathematics is not hard subject for them but 37.32% of untreated students believed that mathematics is hard subject for them (p-value=0.00). The result also indicates that, that the interest of the treated group students in choosing a career that uses mathematics was higher than the students' interest in the untreated group of students.



**Table 2. Result for comparison between treated and untreated students' attitude about mathematics**

|   |  | Group     | SD<br>by % | D<br>by % | N<br>by % | A<br>by % | SA<br>by % | Mean | P-value |
|---|--|-----------|------------|-----------|-----------|-----------|------------|------|---------|
| 1 | I enjoy learning mathematics.                            | Untreated | 8(11.94)   | 24(35.82) | 8(11.94)  | 13(19.40) | 14(20.90)  | 3.01 | 0       |
|   |  | Treated   | 0(0.00)    | 0(0.00)   | 1(2.27)   | 9(20.45)  | 34(77.27)  | 4.75 |         |
| 2 | I am good at math.                                       | Untreated | 6(8.96)    | 22(32.84) | 17(25.37) | 16(23.88) | 6(8.96)    | 2.91 | 0       |
|   |  | Treated   | 0(0.00)    | 0(0.00)   | 10(22.73) | 24(54.55) | 10(22.73)  | 4    |         |
| 3 | I do mathematical activities in my spare time            | Untreated | 7(10.45)   | 16(23.88) | 10(14.93) | 24(35.82) | 10(14.93)  | 3.20 | 0.23    |
|   |  | Treated   | 2(4.55)    | 5(11.36)  | 8(18.18)  | 17(38.64) | 12(27.27)  | 3.72 |         |
| 4 | mathematics is the hard subject for me                   | Untreated | 13(19.40)  | 20(29.85) | 9(13.43)  | 14(20.90) | 11(16.42)  | 2.85 | 0       |
|   |  | Treated   | 29(65.91)  | 13(29.55) | 2(4.55)   | 0(0.00)   | 0(0.00)    | 1.38 |         |
| 5 | I enjoy solving mathematical problems                    | Untreated | 6(8.96)    | 13(19.40) | 11(16.42) | 25(37.31) | 12(17.91)  | 3.35 | 0       |
|   |  | Treated   | 0(0.00)    | 0(0.00)   | 4(9.09)   | 21(47.73) | 19(43.18)  | 4.34 |         |
| 6 | When I have math homework, I can't wait to complete them | Untreated | 2(2.99)    | 7(10.45)  | 27(40.30) | 27(40.30) | 4(5.97)    | 3.35 | 0.065   |
|   |  | Treated   | 4(9.09)    | 9(20.45)  | 8(18.18)  | 18(40.91) | 5(11.36)   | 3.25 |         |
| 7 | I can get good grades in math.                           | Untreated | 1(1.49)    | 7(10.45)  | 18(26.87) | 31(46.27) | 10(14.93)  | 3.62 | 0.006   |
|   |  | Treated   | 0(0.00)    | 1(2.27)   | 4(9.09)   | 21(47.73) | 18(40.91)  | 3.36 |         |
| 8 | I want to choose a career that uses mathematics          | Untreated | 2(2.99)    | 10(14.93) | 10(14.93) | 22(32.84) | 23(34.33)  | 3.80 | 0.032   |
|   |  | Treated   | 0(0.00)    | 0(0.00)   | 2(4.55)   | 15(34.09) | 27(61.36)  | 4.57 |         |

### 3.3. Comparison between treated and untreated students' attitude about Technology and Engineering

Based on table 3, 97.73% from the treated group and 73.13% from untreated group of students enjoy learning to use technology (p-value 0.00). Similarly, 78.28% from the treated group and 46.27% from untreated group of students believed that they can be successful in a career in engineering ((p-value 0.00)). This shows that the level of

students' attitude to be successful in a career in engineering for the treated group is higher than the untreated group of students. This result is also similar to (Akdağ & Güneş, 2016) which indicates STEM integrated problem-based STEM learning activities have had considerable effects on the students' attitudes towards STEM and STEM career interest. Problem-based STEM learning can increase the effectiveness of STEM education, make students' learning meaningful and easy, and affect students' attitudes towards their future careers. From the result, one can concluded that STEM

activities improve the STEM attitudes of the students (Sarac, 2018). Also, the finding of (Mohd Shahali et al., 2016) indicates that STEM Learning through engineering design positively affects students' interest. But results from table 3 show that there is no significant difference between treated and untreated groups about the enjoyment of

learning to use technology, the interest of having more courses on technology at school, the interest of machine work and interest of imagine creating a new product. Also, the result indicated that both groups had a high interest in these areas.

**Table 3. Result for comparison between treated and untreated students' attitude about Technology and Engineering**

|   |  | Group     | SD by % | D by %    | N by %    | A by %    | SA by %   | Mean | P value |
|---|--|-----------|---------|-----------|-----------|-----------|-----------|------|---------|
| 1 | I enjoy learning to use technology                           | Untreated | 5(7.46) | 8(11.94)  | 5(7.46)   | 24(35.82) | 25(37.31) | 3.83 | 0       |
|   |  | Treated   | 0(0.00) | 0(0.00)   | 1(2.27)   | 8(18.18)  | 35(79.55) | 4.77 |         |
| 2 | I would like to have more technology courses at school       | Untreated | 1(1.49) | 3(4.4)    | 4(5.97)   | 27(40.3)  | 32(47.76) | 4.28 | 0.527   |
|   |  | Treated   | 0(0.00) | 0(0.00)   | 3(6.82)   | 16(36.36) | 25(56.82) | 4.5  |         |
| 3 | If I learn engineering, then I can improve things every day. | Untreated | 3(4.48) | 1(1.49)   | 10(14.93) | 29(43.28) | 24(35.82) | 4.38 | 0.697   |
|   |  | Treated   | 1(2.27) | 1(2.27)   | 11(25.00) | 16(36.36) | 15(34.09) | 3.97 |         |
| 4 | I am interested in machine work                              | Untreated | 2(2.99) | 2(2.99)   | 5(7.46)   | 17(25.37) | 41(61.19) | 3.83 | 0.831   |
|   |  | Treated   | 0(0.00) | 1(2.27)   | 4(9.09)   | 11(25.00) | 28(63.64) | 4.5  |         |
| 5 | I like to imagine creating new products                      | Untreated | 2(2.99) | 5(7.46)   | 13(19.40) | 26(38.8)  | 21(31.34) | 3.31 | 0.093   |
|   |  | Treated   | 1(2.27) | 0(0.00)   | 3(6.82)   | 20(45.45) | 10(45.45) | 4.31 |         |
| 6 | I believe I can be successful in a career in engineering.    | Untreated | 3(4.48) | 16(23.88) | 17(25.37) | 19(28.36) | 12(17.91) | 4.16 | 0.007   |
|   |  | Treated   | 1(2.27) | 4(9.09)   | 5(11.36)  | 13(29.55) | 21(47.73) | 4.11 |         |

### 3.4. Comparison between treated and untreated students' attitude about Science, Technology, Engineering and Mathematics

Based on table 4, from treated group 97.73% of students and from untreated group 85.87% of students understand that science,

Mathematics, technology and engineering fields complement each other. Even though both groups had a high understanding about the complementarities of science, mathematics, technology and engineering fields, there was a statistically significant difference between treated and untreated students (p-value=0.000). Similarly, 90.91% from treated group and 61.19% from



untreated group of students were interested have a job that involves science, mathematics, engineering or technology. And the result also shows that there was a significant difference in interest between treated and untreated students about having a job that involves science, mathematics, engineering or technology ( $p$ -value=0.002). There is a mean score difference (mean for treated group =4.11 and mean for untreated group=3.47) about the interest of having a job that involves science, mathematics, engineering or technology. This finding is supported by (Akdağ & Güneş, 2016) who indicate the students who involve in the STEM activities had improved their

creativity, motivated in the classroom and had a great interest to work in STEM-related fields in the future. The finding of (Saraç, 2018) also indicates that STEM instruction significantly increases students' attitudes towards STEM disciplines and increases students' interests particularly in occupations related to engineering and technology. However, a significant difference in perception about the importance of science and mathematics to learn technology and engineering, the importance of STEM in the life of enjoyment of learning to use technology was not observed between the two groups.

**Table 4. Result for comparison between treated and untreated students' attitude about Science, Technology, Engineering and Mathematics**

|   |   | Group     | SD by %   | D by %   | N by %   | A by %    | SA by %   | Mean | P value |
|---|---|-----------|-----------|----------|----------|-----------|-----------|------|---------|
| 1 | Science, mathematics, technology and engineering fields complement each other             | Untreated | 0(0.00)   | 2(2.99)  | 8(11.94) | 34(50.75) | 23(34.33) | 4.16 | 0       |
|   |   | Treated   | 0(0.00)   | 1(2.27)  | 0(0.00)  | 8(18.18)  | 35(79.55) | 4.75 |         |
| 2 | To learn engineering and technology, I have to be good at science and mathematics         | Untreated | 1(1.49)   | 2(2.99)  | 5(7.46)  | 32(47.76) | 27(40.30) | 4.22 | 0.065   |
|   |   | Treated   | 0(0.00)   | 3(6.82)  | 0(0.00)  | 14(31.82) | 27(61.36) | 4.47 |         |
| 3 | Knowing how to use math and science together will allow me to invent useful things        | Untreated | 3(4.48)   | 2(2.99)  | 1(1.49)  | 27(40.30) | 34(50.75) | 4.29 | 0.304   |
|   |   | Treated   | 0(0.00)   | 0(0.00)  | 0(0.00)  | 16(36.36) | 28(63.64) | 4.63 |         |
| 4 | Science, technology, engineering and mathematics are very important in life.              | Untreated | 1(1.49)   | 2(2.99)  | 3(4.48)  | 16(23.88) | 45(67.16) | 4.52 | 0.689   |
|   |   | Treated   | 0(0.00)   | 0(0.00)  | 3(6.82)  | 11(25.00) | 30(68.18) | 4.61 |         |
| 5 | Science, technology, engineering and mathematics are good for the future of our country   | Untreated | 1(1.49)   | 1(1.49)  | 5(7.46)  | 16(23.88) | 44(65.67) | 4.50 | 0.275   |
|   |   | Treated   | 0(0.00)   | 0(0.00)  | 0(0.00)  | 10(22.73) | 34(77.27) | 4.77 |         |
| 6 | I would like to have a job that involves science, mathematics, engineering or technology. | Untreated | 11(16.42) | 7(10.45) | 8(11.94) | 21(31.34) | 20(29.85) | 3.47 | 0.002   |
|   |   | Treated   | 1(2.27)   | 0(0.00)  | 3(6.82)  | 13(29.55) | 27(61.36) | 4.47 |         |

#### 4. CONCLUSION AND RECOMMENDATIONS

This study was conducted to analyse the effect of STEM center education on students' attitude about science, mathematics, technology and engineering. The finding from chi-square and mean values indicated that students who attend high school with STEM center have good participation in science and mathematics subjects, they enjoy solving mathematical problems, they enjoy using technology, they believe that they can be successful in the career of engineering. In addition, they like to have a job in the fields of science, mathematics, engineering or technology, and they have a better understanding of the complimentary of science, mathematics, technology and engineering than students who attended conventional high schools. The interview result also shows that the program is effective in their learning, and it helps to develop their skills, makes the class more enjoyable, increases their interest in the profession of science, mathematics, technology and engineering and helps them to select their future career. As a result, STEM program education affects students' perceptions positively. This research finding was directly in line with other previous findings which indicate students' attitudes

towards STEM disciplines and STEM career interests in STEM-related occupations significantly increased by problem-based STEM activity. This in turn, encourages them to join careers related to science, mathematics, technology and engineering in the future. This implies that STEM program education affects students' perceptions positively. Thus, based on these findings, the researcher recommended that in developing countries like Ethiopia the STEM center education must be promoted to increase student's perception of STEM-related careers and to have well qualified educators in the area.

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