Indonesian Students’ Attitude and Interest in STEM: An Outlook on The Gender Stereotypes in The STEM Field

Hadi Suwono1*, Rifka Fachrunnisa2, Chokchai Yuenyong3, and Linda Hapsari4

124Biology Department Universitas Negeri Malang Malang, Indonesia
3Science Education Department Khon Kaen University, Khon Kaen, Thailand

*Corresponding author’s e-mail address: hadi.suwono.fmipa@um.ac.id

Abstract. STEM education could be reckoned as a noble thing in the Indonesian Educational System in the last few years. This paper is a preliminary attempt to investigate the students’ attitude and interest in STEM regarding the gender perspective of Senior High School’s student in Malang, Indonesia. To explore the attitude and interest in the gender stereotypes, this quantitative method study has been conducted. 357 students participated in the survey which comprised 126 males and 231 females. The survey contended 40 items of belief’s indicators in the STEM field such as science, technology, engineering, mathematics and the STEM. Besides, at the end of the survey’s section, there are some options for future study programs and career to be selected by the learner. Unexpectedly, the finding of this project revealed that male has a more positive belief in the most of STEM field, such as technology, engineering, mathematics, and STEM, rather than female. In comparison, the female has a more positive belief than male in the science only. The marked investigation of emerging from the data comparison was both of male and female have a higher interest in the social field and medicine. However, the additional interest of male and female was significantly different. In males, we found that they have more interest in engineering, while females have an interest in biology. This study also disclosed that the factors, namely family support, family financial, friends, teachers, and hobby, determined both attitude and interest in STEM among students in Malang.

1. Introduction
In the current fast changing world, STEM education is considered as a visible elucidation in preparing new generation to deal with the global pace. STEM education has been running for the program that can help student to foster various strategies in tackling interdisciplinary problems and advancing their scientific leadership and economic growth in the future [14]. Besides, there has been numerous reported about innovation and development as the evident of STEM education’s outcome in various countries [4]. To engage with STEM education, thus needed the competencies as the fuels to foster stem in the educational system to fulfil the requirement of the current or future STEM workplaces.

This new movement has impacted globally which induced a massive engagement with STEM education in many countries around the world over past 20 years is proving of the crucial STEM education challenges to be addressed [14]. Countries in the Europe such as France, Germany, The Netherlands, Switzerland and Austria has been struggling to enhance their people in operating and creating technologies to boost their domestic production [3]. In the same way, Australia also improve STEM skills in their educational system intensively due to the fact that there is less student in the college who want to pursue STEM field. The main indicator of this issue was showed by the fewer
qualified applicant for engineering compared to natural sciences and medical fields. Likewise, in the USA, they have a similar issue to find qualified employer in technical and engineering skills to fulfill more than 500,000 jobs for the manufacturing sector [12].

In the light of Indonesian education system context, STEM education can be an overlapping part among the three pillars of the current Indonesian curriculum. The three pillars included character, literacy and competency. Developing STEM education can mean developing those pillars too. Knowing that Indonesia was considered as the big seven countries which has the most STEM graduates in the world, the fact of the ratio or comparison with the population rate in Indonesia showed that it was not the big seven anymore. There were only seven people who were graduated from STEM among 10,000 population[12]. It was an alert that the current system should improve the STEM graduates. To bring it to fruition, there many reported studies were specifically focused on developing approach for students’ carrier pathway to engage with STEM. This was presumably adopted from the replication of the previous studies in the decade ago, when the world paradigm set science education as the focal point for development. Varieties branches of education – such as psychology, sociology and philosophy- also supported the discussion on carrier in science’s topic, chiefly scrutinizing the attitude and interest in science. Those two facets are always juxtaposed together with the carrier aspirations discourse. The gender stereotypes, in other way, also completed the puzzle due to many studies disclosed that the stereotypes take into account in determining both of attitude and interest among students significantly.

On the one hand, the attitude in science has been manifested as a perplexing combination of the eagerness to know and understand, to examine the method of the statements, to find data and their meaning, to require for verification, to adhere to logic and to envisage the premises and the consequences [4]. Reported that several large quantitative studies found that overall females’ attitude towards science are less positive than boys [2]. They also revealed that the attitude declines more significantly with age. In the other replications, there are seven factors significantly correlated with the females’ attitudes towards science, namely equity, access, curriculum, pedagogy, reconstruction the nature, culture of science and identity. The interest, on the other hand, has been rationally operated as a multidimensional framework which requires both of cognitive and emotional categories [14], [13] conveyed that this behaviour attribute represents a specific personal orientation, a reference valuation, or a consciousness of feasibilities for an action. Their replication also revealed that to concrete the action, interest acts as an effect provider for emotional reactions, declarative knowledge, and procedural knowledge of the action’s engagement. In term of interest in learning, presumed that interest has positive motivational features for long periods of time. Steering Indonesian students to choose STEM field as their life carrier would require immense endeavour since carrier pathway in Indonesia highly correlated with the social and cultural discourses. Few researchers have addressed the problem of fostering STEM education in Indonesia, yet it has not been established whether there is a distinct between male and female’s attitude and interest in STEM. This present study, therefore, sheds new light on the gender stereotypes in the STEM field among Indonesian students.

2. Methodology
To identify students’ attitude and interest in STEM based on gender perspective, this study employed a mixed method approach. On the quantitative stage, we administered survey by deploying a questionnaire. The questionnaire was operationalized through the use of a Likert-Scale questionnaire contented 40 indicators of the two aspects – interest and attitude. However, before the survey was carried out, an initial pilot test questionnaire was conducted to test the questionnaire. There are 126 males and 231 females from Malang’s senior high school participated in this survey. Because the participants in this project were under 18 years old, a parental consent form was required before undertaking the survey. Probability sampling (or, specifically, random sampling) was employed in selecting the population sample. The population sample is explained as a small population subset which is representative of the whole [7]. Thus the selected sample (357 students) was determined by
the total number of participants whose parents consented to completion of the questionnaire. On the qualitative stage, however, we conducted interview to the four lowest and highest score in questionnaire. The interview was aimed to explore the social and cultural background of the research participants. The result of the interview was then analysed using thematic coding analysis.

3. Results

3.1. Quantitative Result

Based on the Table 1, the attitude toward science of male students is lower than female students with a significance value of 0.041 which means that the two of them are differ significantly. The mean value of mathematics in male students was 182.06 higher than female students with a value of 173.38. The significance value is 0.446 which means that the attitude of male and female students to Mathematics is not significantly different. In the field of Engineering, the attitudes of male students are higher than the attitudes of female students with a significance value of 0.000. This means that the attitudes of male and female students in the Engineering field differ significantly. In the field of technology, the attitudes of male students are also higher than female students with a significance value of 0.030, which means that there are significant differences in attitudes of male and female students in the field of technology. In the field of STEM the attitude values of boys are 194.04 and the attitude of female students is 170.80 with a significance value of 0.041 which means that there are significant differences in attitudes between male and female students in the STEM field.

| Subject   | Male  | Female | Asymp. Sig. (2-tailed) | Significance |
|-----------|-------|--------|------------------------|--------------|
| Science   | 170.76| 194.11 | 0.041                  | Significant  |
| Mathematics| 182.06| 173.38 | 0.446                  | Not significant |
| Engineering| 207.44| 163.48 | 0.000                  | Significant  |
| Technology| 194.96| 170.29 | 0.030                  | Significant  |
| STEM      | 194.04| 170.80 | 0.041                  | Significant  |

The differences in attitudes of male and female students in each STEM field can be seen from the results of factor analysis. Factor analysis is carried out to identify fundamental factors that can explain the correlation of a series of variables, identification of new smaller variables to replace uncorrelated variables from a series of origin variables that are correlated from multivariate analysis, and identification of small variables that stand out from bigger variable. The requirement for factor analysis is the fulfillment of several assumptions, namely: 1) the magnitude of the correlation between the independent variables must be strong enough (above 0.5), 2) partial correlation, the correlation between the two variables must be small by assuming the other variables are fixed from the Anti-Image Correlation, 3) testing the entire correlation matrix measured with the Bartlett Test of Sphericity or Measure Sampling Adequacy (MSA), which requires a significant correlation between at least a few variables. Based on the results of factor analysis, it is known that there are some differences in attitudes between male and female students towards the STEM field. The differences in attitudes of male and female students can be seen in the communality table. Communality aims to see the proportion of certain variable variances explained by factors. The higher the value of communality means that these variables increasingly have the same factor. Communality test results can be seen in Table 2.

| Subject   | Male  | Female | 1   | 2   | 1   | 2   |
|-----------|-------|--------|-----|-----|-----|-----|
| Science   | 0.853 | 0.004  | 0.868| -0.009|
| Mathematics| 0.750 | -0.030 | 0.750| -0.353|
According to Table 2, there has been identified 6 variables, 2 factors were formed. Determination of variables included in the factor is determined by looking at the greatest correlation value. In men, the greatest STEM correlation at factor 1 is 0.853. Likewise science (0.750), Engineering (0.727), and Technology (0.578) have a greater correlation in factor 1. Mathematics is the biggest correlation at factor 2, which is 0.953. In female students, the greatest correlation value of STEM at factor 1 is 0.868, followed by science (0.750) and engineering (0.551). While Technology and Mathematics are the biggest correlations in factor 2 with a value of 0.705 and 0.606. Based on the description above, it can be concluded that members of factor 1 in male students are STEM, Science, Engineering, and Faith. While factor 2 members are Technology and Mathematics.

On the other hand, interest in study programs for male and female students was carried out in a descriptive analysis. Table 3 showed that in the male students the highest mean score is in the social field (3.12) followed by the medical field (3.03) and engineering (2.88). This is almost the same for female students (Table 4). The highest mean score is in the social field (3.18), then followed by the medical field (3.06), and biology (2.95). But when compared to each field, the average value in the fields of physics, chemistry, biology and social was higher for female students than for male students. While the average value of mathematics, engineering, and technology is higher for male students than female students.

| Table 3. Descriptive analysis of interest in study programs among male students |
|---|---|---|---|---|
| N | Minimum | Maximum | Average | Standard Deviation |
|---|---|---|---|---|
| Physics | 126 | 1.00 | 4.60 | 2.59 | 0.88 |
| Chemistry | 126 | 1.00 | 5.00 | 2.50 | 1.16 |
| Biology | 126 | 1.00 | 5.00 | 2.69 | 0.95 |
| Mathematics | 126 | 1.00 | 5.00 | 2.88 | 1.03 |
| Medicine | 126 | 1.00 | 5.00 | 3.03 | 1.04 |
| Engineering | 126 | 1.00 | 4.50 | 2.77 | 0.82 |
| Technology | 126 | 1.00 | 5.00 | 2.76 | 1.03 |
| Social Work | 126 | 1.00 | 5.00 | 3.12 | 0.86 |
| Valid N (listwise) | 126 |

| Table 4. Descriptive analysis of interest in study programs among female students |
|---|---|---|---|---|
| N | Minimum | Maximum | Average | Standard Deviation |
|---|---|---|---|---|
| Physics | 231 | 1.00 | 4.60 | 2.64 | 0.78 |
| Chemistry | 231 | 1.00 | 5.00 | 2.59 | 1.13 |
| Biology | 231 | 1.00 | 5.00 | 2.74 | 0.88 |
| Mathematics | 231 | 1.00 | 5.00 | 2.95 | 1.06 |
| Medicine | 231 | 1.00 | 5.00 | 3.06 | 1.04 |
| Engineering | 231 | 1.00 | 4.60 | 2.47 | 0.79 |
| Technology | 231 | 1.00 | 5.00 | 2.79 | 0.97 |
| Social Work | 231 | 1.00 | 5.00 | 3.18 | 0.81 |
3.2. Qualitative Result

The qualitative approach was devised to understand the experiences of the participants who showed the highest and lowest score in interest and attitudes towards STEM based on score calculated in the quantitative stage. In fact, more than one candidate had the same score, but only one was selected for follow-up interviews. This process was complicated by ethical issues. I had of course chosen those who had consented for the interview process. There were four participants who participated in interview section, which had been conducted in accordance with the plan. The remaining prospective candidates had rejected the consent due to the others matters such as desire to go home earlier, or a preference to do extra-curricular school activities. As mentioned in the Methods section, the analysis was conducted using thematic coding. [6] Affirms that the aims of this analysis are suitable for studies that are theoretically conducted based on group comparison (in this study, extremes group) in relation to a specific issue (here, creativity in the science education). He posited that with this analysis technique, different views can be revealed. In addition, he also suggested the following procedure when undertaking thematic coding: provide a brief description of each case (participant background); develop a thematic structure; and refine the interpretation of thematic domains or make key questions. In this analysis process, the four interview transcripts were read several times.

Afterwards, some codes were extracted from the passages, which were separated based on the group themes of participants (attitude and interest in STEM). Each extracted code was then separated on paper. Following this, these codes were grouped together, and the revealed codes from different groups were selected. Then, analysis revealed one code which appeared in both the low and high groups. Thus, this established a communality amongst the participants in different groups [1]. Based on the theme extraction, the choice of study program interests is strongly influenced by the encouragement of family and close relatives, especially supported by the family's economic background which is sufficient. Other factors that can influence the interest in choosing a study program are friends, teachers, and hobbies. At the time of the interview, most students said that the selection of study programs had been prepared by the family, especially parents, for various reasons, such as continuing the family business, coming from families who all had profession as doctors, or indeed because of the wishes of children who had been supported by parents.

4. Discussion and conclusion

Data analysis revealed that there were differences in attitudes between male and female students in STEM. Male students show a more positive attitude towards the fields of Mathematics, Engineering, Technology, and STEM. Whereas female students showed a more positive attitude in the field of science and piety. The results of this study are supported by the 2012 PISA results which suggest that male are superior to female in mathematics performance. Female feel less motivated to learn mathematics and are less confident in their abilities compared to men [12]. For technology and engineering, [3] states that the field of STEM is dominated by male. Women mostly choose the field of biology or science, so they choose less in the fields of engineering, computer science, and mathematics. The results of research conducted which examined the application of STEM-based PBL for students to improve scientific literacy. In addition, he also disclosed that male is superior to indicators of science-technology (S-T), science-mathematics (S-M), and science-technology-engineering (S-T-E). Whereas the female class excels for science indicators only. According to [9] Women tend to prefer hands-on learning experiences, make intuitive judgments based on feelings, always oriented, and feel comfortable with ambiguity. While men tend to do analysis in learning, think logically and rationally, and enjoy working with symbols like structures. So that the STEM field that reflects an analytical approach tends to be more suitable for boys than girls. [15] also revealed the factors that caused females had lower participation in science field: history of science education; the international situation in science for females; sociocultural accounts pertained with the science attitudes and environment of the classroom; and the policies related to the gender issues.

The analysis shows that male and female students share a high interest in social and medical fields. In male students, social fields that have the highest interest are teachers, and management. Whereas for
female students, social fields that have the highest interest are management and linguists, especially Arabic. The second highest interest is in the field of medicine. Most students, both male and female, choose medicine (doctors, dentists, nurses, midwives, pharmacists, and nutritionists) as a choice of their future study programs and careers. This is usually due to the child's own wishes and has been supported by parents or parents' wishes even though the child does not agree. The third highest interest in male students is in the field of engineering while the female students are in the field of science. This is in accordance with the opinion which states that female students are more interested in science issues, support science inquiry, and responsibility for environmental resources than male students. This also supported by the replication of [11] which states that female students prefer to study biology or science related to the choice of work in the future [8]. This is due to the high and low attitudes of students towards science are influenced positively, among them are the work desired by students, teaching and learning activities in the classroom, and the amount of time spent studying science. In career aspirations, girls are more likely to choose careers that will not interfere with their future roles as parents or parents. While boys have higher long-term expectations for themselves [3].

Taken together, this study highlights that in introducing STEM education in Indonesia can be embarked with taking awareness of the plot of attitude and interest among students. It is useful to consider a transformation in science curriculum in Indonesia to flourish those traits in supporting the increase economic and technology of Indonesia, thus Indonesia can be juxtaposed with the other advanced countries around the world. This transformation, however, has to be supported by all parties in the education system including the parent. School-parent engagement in the most mainstream school also still should be improved. In this case, this program can depress the discrepancy between female and male interest and attitude towards science. Moreover, by knowing the plot of those two aspect, teachers in the classroom should be aware to design the learning strategy in accommodating the improvement on STEM interest and attitude among both of female or male students. Furthermore, the stakeholder – Indonesian Minister of Education- should take it as a granted by conducting some programmes that can support the advancement of STEM education. It might be concluded from this that by taking more enactment of developing STEM education by considering the two traits – interest and attitude- can decrease the impact of the determinant factors which have been investigated in this study – such as family support, family financial, friends, teacher, and hobby-. Thus, they will not be stumbling blocks to foster STEM education and increase STEM graduate in Indonesia

References
[1] Abbott A 2014 The system of professions: An essay on the division of expert labor (University of ChicagoPress)
[2] Brotman J S and Moore F M 2008 Girls and science: A review of four themes in the science education literature Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching 45 pp 971–1002
[3] Chant S and Sweetman C 2012 Fixing women or fixing the world? ‘Smart economics’, efficiency approaches, and gender equality in development Gender & Development 20 pp 517–529
[4] Educational Policies Commission 1962 Education and the disadvantaged American
[5] English L D 2016 STEM education K-12: perspectives on integration International Journal of STEM Education 3 p 3
[6] Flick U 2014 An introduction to qualitative research (Sage)
[7] Fowler Jr F J 2013 Survey research methods Sage publications
[8] Hango D W 2013 Gender differences in science, technology, engineering, mathematics and computer science (STEM) programs at university (Statistics Canada Statistique Canada)
[9] Kulturel-Konak S, D’Allegro M L and Dickinson S 2011 Review of gender differences in learning styles: Suggestions for stem education Contemporary Issues in Education Research 4 pp 9–18
[10] Lacey T A and Wright B 2009 Employment outlook: 2008-18-occupational employment projections to 2018 Monthly Lab. Rev. 132 p 82
[11] Larson L M, Stephen A, Bonitz V S and Wu T F 2014 Predicting science achievement in India: Role of gender, self-efficacy, interests, and effort Journal of Career Assessment 22 pp 89–101
[12] Organisation for Economic Co-operation and Development 2014 PISA 2012 results: What students know and can do (volume I, revised edition, February 2014): Student performance in mathematics, reading and science (OECD Publishing)
[13] Renninger K A, Hidi S, Krapp S and Renninger A 2014 The role of interest in learning and development Psychology Press.Sala-i-Martin, X., & Schwab, K. (Eds.). (2011) The global competitiveness report: 2011-2012 World Economic Forum
[14] Sanders M 2009 Integrative STEM education: primer The Technology Teacher 68 pp 20–26
[15] Scantlebury K, Baker D, Sugi A, Yoshida A and Uysal S 2007 Avoiding the issue of gender in Japanese science education International Journal of Science and Mathematics Education 5 pp 415–438