The effect of STEM interest base on family background for secondary student

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Abstract. The integration of STEM education in all fields can contribute to the economic and educational development of a nation. In today's global age, all countries around the world need to integrate STEM education into school curricula to foster STEM students' interest from elementary education to college. The purpose of this study was to test the impact of STEM interest based on family background for secondary students. This study conducted a quantitative paradigm involving 150 secondary students. The results show that there is a STEM interest based on family background. In addition, STEM interest is strongly influenced by student gender. The findings of this study provide implications for teachers and school curriculum makers that students' interest in STEM subjects is influenced by students' family background and gender. Future researchers need to delve deeper into the factors that influence students on STEM subjects based on student attitude, achievement, and socioeconomic status.

1. Introduction

The recent integration of STEM education is widely discussed by many countries around the world as STEM education contributes significantly to the development of a country's economy. The output of STEM education is not just about academics and economics. But STEM education produces social, personal, and economic development that requires more than just STEM skills and knowledge building [1]. In addition, STEM education can help students develop soft skills, general skills, and 21st-century skills. Therefore, STEM education needs to be integrated into the process of implementing school learning to enhance students' interest in STEM education. However, the reality in the field showed that students are becoming less interested in STEM. For example, Turkey needs workers in the STEM field of nearly one million in 2016-2023. However, it is estimated that about 31% of the country's needs are not met [2]. In addition, 30% of Australian employers also have difficulty in recruiting qualified individuals to fill the jobs. Whereas Europe (from 24.8% in 1999 to 22.7 in 2005). The USA has a burden to find qualified applicants' capabilities to fill 600,000 jobs in the manufacturing industry [3]. Based on previous studies, Indonesia found a decrease in student achievement in science and mathematics subjects [4]. Based on the mean score of PISA 2018, Indonesian students' achievements in math and science were ranked 72nd and 70th out of 78 countries [5]. Besides, the results of TIMSS 2015 showed that Indonesian 4th graders' scores in science and math were ranked 44th out of 47 and 49 participating countries [6]. Identifying students' interest in starting elementary school can shape life and academic experiences, student attitude, the choice to work in the future of STEM [7]. Therefore, identifying students' interest in STEM careers in high school is important [8]. The process of teaching and learning in STEM encourages students to cooperate, communicate, critical thinking, and creative skills [2]. Students' interest in STEM can improve academic achievement [9].
Many factors that influence students' interest in STEM education are (1) student attitude toward science, (2) family background, (3) student achievement in science and mathematics, (4) socioeconomic status, and (5) gender [10]. In this study, the researchers discussed only factors that influence students' interest in STEM education based on their family background and gender.

The family background has contributed a positive impact for the student to complete the educational stage, educational careers, and educational achievement [11,12]. The significance of parental influence takes into account students internalizing in academic performance [11]. Similarly, parental education and occupations affect student decision-making in the mathematics and science fields [11,13]. The students' interest in STEM can influence how parents talk to their children about STEM [14]. Therefore, the family background is crucial factors for student attainment; however, that matter of fact was unmeasured substantially [15].

Based on previous research results show that there is a difference in math/science learning outcomes for boys and girls [16]. The discrepancy in the results of previous studies shows that male students are better in math/science aspects than female students [16,17]. Gender-based disparities will have an impact on the number of students in the high school (high school) science stream. Overall, the percentage of male students entering the science stream outperformed women in the range of 80.20% [18]. This shows the gender imbalance in terms of involvement in the subjects of mathematics and science. The issues discussed need to be taken into consideration as STEM education influences the nation's success, especially for secondary students. Students' interest in STEM can arise at the beginning of the secondary level because, at this time, the student can develop their knowledge about the subject that they are most interested in.

2. Methods

The paradigm for this study was to use quantitative methods. The population in this study were grade 8 students of Simanosor Julu, Indonesia, in the 2018/2019 academic year, consisting of 240 students. The random sampling method was applied to get the sample for this research. A total of 150 students involved in this research. Instruments conducted were questionnaires consisting of 50 items. The analysis scales used based on Likert. Content validity was conducted by two experts in education. In terms of construct validity, it was based on the results of the Exploratory Factor Analysis output with the SPSS 21 program. As the value of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) was 0.631 (> 0.5), factor analysis could be performed. Based on the rotated component matrix output, the obtained distribution of items for each factor that had an eigenvalue of more than 1 (one) was six factors. Factor 1 (items 1-11), factor 2 (items 12-22), factor 3 (items 23-33), factor 4 (items 34-44), and factor 5 (items 45-50). Instrument reliability was tested using Rasch model analysis using Winsteps software version 3.71.0.1.

Whereas to test the influence of STEM interest base on background family was using descriptive statistics and independent sample t-test. Before running the t-test analysis test, the researcher needs to meet the test of assumptions of normality and homogeneity. The test of assumption was that it was a test of normality and homogeneity. Normalization test analysis used Kolmogorov-Smirnov. The results of normality analysis were found to be p = 0.200 (p > 0.05). Therefore, it could be concluded that the data distribution in this study was normally distributed. While the test of homogeneity assumption was based on Levene's Test. The analysis results were found to be p = 0.06 (p > 0.05). It could be concluded that the test of homogeneity was fulfilled.

3. Result and Discussion

Based on the findings of the study, there are differences in STEM interest based on family background by gender (Table 1). The mean score obtained by male students is higher than that of female students. STEM interest based on family background by gender can be seen during the teaching and learning (T&L) process in schools. During the discussion of problem-solving the male students are more active in giving ideas than the female students. The female students are still embarrassed to convey the ideas they have. Female students worry when the ideas they give are incorrect. In addition, when conducting
explorations, male students are more actively seeking information from a variety of sources than female students. These are factors that may be a hindrance and a hindrance to girls and are the cause of the difference in mean scores obtained by boys and girls. The results of this study are in line with previous studies that found that differences in reasoning in the spatial aspects of students were based on gender. This difference is due to the nervous and mental systems belonging to male and female students [16]. In addition, male students’ mental states are stronger than female students [16]. Male students work better and are more active than female students [19]. Based on previous research results have shown that there are gender differences in solving mathematical tasks [16,20].

Female students are more exposed to anxiety than male students in math subjects. The mathematical self-concept of female students is lower than that of male students [21,22]. The negative attitude of female students towards math/science is higher than that of male students [23]. Emotions are less fun while studying math/science subjects [24]. Based on the results of previous studies, it is found that the confidence or confidence in the skills possessed by female students is lower than that of the male students [17,25]. The gap in self-confidence in mathematics/science students’ ability by gender has continued to this day [26]. Female students achieved a simpler solution than male students in certain tasks [27]. This is also reinforced by the findings in this study shown in Table 1.

| Table 1. The mean score of STEM interest base on family background for gender. |
|-----------------|-----------------|--------|
| Aspect          | Gender          | Mean   |
| STEM interest base on family background | Male      | 96.62  |
|                 | Female          | 96.42  |

According to Table 1, the mean score values related to STEM interest based on family background by gender were male (mean = 96.62) and female (mean = 96.42). This result can be concluded that the mean score of boys is higher than the mean score of female students with a score difference of 0.2. Therefore, gender aspects have a bearing on influencing STEM interest based on family background for secondary school students. In addition, the analysis results showed that Independent sample t-tests were found to be t (148) = 2.91, p = 0.044. Therefore, there are differences in STEM interest based on family background by gender.

Furthermore, the factors that influence students’ STEM interests are due to the work background and level of education their parents have. As the results of the study were conducted. Table 2 shows the frequency of students’ interest scores on STEM subjects based on family background, especially on occupational and parental education levels.

In this study, the criteria students with good STEM interests based on their work and parental educational background had a mean score of 237-200 (n = 55). Whereas students with a low score of 200 (<200) or 199-144 (n = 95), the students in question fit into the criteria of students who are less interested in STEM-based on the work and education their parents have. Table 2 shows that 36.67% (n = 55) with a high interest in STEM came from families with paternal jobs as entrepreneurs (n = 31), civil servants (PNS) (n = 14), employees (n = 5), and farmers (n = 5). While surveyed from the occupations of mothers were PNS (n = 24), housewives (IRT) (n = 19), entrepreneurs (n = 11), and others (n = 1). Furthermore, the highest scores on STEM interest are based on parental educational background. The highest scores were students who had a background in college education (PT) (n = 25), followed by high school education (SMA) (n = 26), secondary school (SMP) (n = 2), and primary school (SD) (n = 2). Whereas for the background of maternal education, the highest scores obtained were from mothers with PT (n = 30), SMA (n = 21), SMP (n = 2), and SD (n = 2). The findings of this study are supported by the results of previous studies that found that work background and parental education level had a significant effect on STEM interest for secondary students [28]. In addition, the family background can guide students from early childhood education to higher education [12].
Table 2. Frequency of student scores on STEM interest based on the family background (parents’ occupation and education).

| Aspects | Parents | Parents’ Occupation and Education | Frequency |
|---------|---------|----------------------------------|-----------|
| Father  | Entrepreneurs | 31 |
|         | PNS      | 14 |
|         | Employees | 5  |
|         | Farmers  | 5  |
| Mother  | PNS      | 24 |
|         | IRT      | 19 |
|         | Employees | 11 |
|         | Others   | 1  |
| Father  | PT       | 25 |
|         | SMA      | 26 |
|         | SMP      | 2  |
|         | SD       | 2  |
| Mother  | PT       | 30 |
|         | SMA      | 21 |
|         | SMP      | 2  |
|         | SD       | 2  |

4. Conclusion
STEM interests for students need to be taken into account in the early stages. One of the factors that influence students’ interest in STEM is the role of parents. Education and career of parents are also often the moderator in directing students to become interested in STEM education. In addition, students’ interest in STEM is also influenced by gender factors. STEM interest based on family background by gender indicates that male students are more interested in STEM subjects than female students. As parents, it is also important to teach and direct their children to prefer STEM education from an early age. Because STEM education has a positive impact on aspects of student attitude, achievement, communication skills, responsibility for solving problems in learning and can stimulate students’ interest in pursuing and working in the future of STEM. In addition to gender and family background factors, another factor that can drive STEM interest for secondary students is the role of the school. School is a key factor in the pursuit of STEM education as a whole to create successful people in the field of STEM.

Based on the findings, it is recommended that other researchers further identify STEM interest based on (a) student attitude toward science, (b) student achievement in science and mathematics, (c) socioeconomic status, and (d) analyze the relationship between these variables.

There are several limitations to this study. This study only tests STEM interest students based on family background. In addition, this study is limited to secondary school student grade 8 in certain schools.

5. References
[1] Timms M J Moyle K Weldon P R Mitchell P and Australian Council for Educational Research (ACER) 2018 Challenges in STEM learning in Australian schools: literature and policy review.
[2] Ergün A 2019 Identification of the interest of turkish middle school students in stem careers: gender and grade level differences 18 1 90–104.
[3] White E 2018 State of STEM 44.
[4] Shin S Rachmatullah A Roshayanti F Ha M and Lee J K 2018 Career motivation of secondary students in STEM: a cross-cultural study between Korea and Indonesia Int. J. Educ. Vocat. Guid. 18 2 203–231.
[5] Schleicher A 2019 PISA 2018 insights and interpretations OECD Publ.
[6] Mullis I V S Martin M O Foy P and Hooper M 2015 TIMSS 2015 International Results in
Mathematics: Fourh Grade Mathematics SAGE Encycl. Educ. Res. Meas. Eval.

[7] Wiebe E Unfried A and Faber M 2018 The Relationship of STEM Attitudes and Career Interest EURASIA J. Math. Technol. Educ. 14 10.

[8] Siregar N C 2020 Interest STEM based on Family Background for Secondary School Students: Validity and Reliability Instrument Using Rasch Model Analysis May 1026–1034.

[9] Siregar N C Rosli R Maat S M and Capraro M M 2020 The effect of science, technology, engineering and mathematics (STEM) project based learning (PBL) on students’ achievement in four mathematics topics Int. J. Math. Educ. 15 1.

[10] Jeffries D Curtis D D and Conner L N 2020 Student Factors Influencing STEM Subject Choice in Year 12: a Structural Equation Model Using PISA/LSAY Data Int. J. Sci. Math. Educ. 18 3 441–461.

[11] Salazar L, Cebolla-Boado H R 2019 Educational expectations in the great recession: has the impact of family background become stronger? Socio-Economic Rev. 1–27.

[12] Vergolini L and Vlach E 2017 Family background and educational path of Italian graduates High. Educ. 73 2 245–259.

[13] McGue M Rustichini A and Iacono W G 2017 Cognitive, Noncognitive, and Family Background Contributions to College Attainment: A Behavioral Genetic Perspective J. Pers. 851 65–78.

[14] Haden C A Jant E A Hoffman P C Marcus M Geddes J R and Gaskins S 2014 Supporting family conversations and children’s STEM learning in a children’s museum Early Child. Res. Q. 29 3 333–344.

[15] Marks G N and Mooi-Reci I 2016 The declining influence of family background on educational attainment in Australia: The role of measured and unmeasured influences Soc. Sci. Res. 55 171–185.

[16] Voyer D Voyer S D and Saint-Aubin J 2017 Sex differences in visual-spatial working memory: A meta-analysis Psychon. Bull. Rev. 24 2 307–334.

[17] Baird C L and Keene J R 2018 Closing the Gender Gap in Math Confidence: Gender and Race / Ethnic Similarities and Differences in the Effects of Academic Achievements among High Math Achievers Int. J. Gender,Science Technol. . 10 3 378–410.

[18] Fitriani A Prayogi S and Hidayat S 2015 Pengaruh Model Pembelajaran Predict, Observe, Explain, Write (Poew) Terhadap Pemahaman Konsep Fisika Ditinjau Dari Jenis Kelamin Kelas Xi Ipa Sma Negeri 1 Empang Lensa J. Kependidikan Fis. 3 1 227.

[19] Han F 2019 Self-concept and achievement in math among australian primary students: Gender and culture issues Front. Psychol. 10.

[20] Sunde P B Sunde P and Sayers J 2020 Sex differences in mental strategies for single-digit addition in the first years of school Educ. Psychol. 40 1 82–102.

[21] Hyde J S Bigler R S Joel D Tate C C and van Anders S M 2019 The future of sex and gender in psychology: Five challenges to the gender binary Am. Psychol. 74 2 171–193.

[22] Wolff F Helm F Junge F and Möller J 2019 Are Dimensional Comparisons Performed Unconsciously? An Investigation of the Internal/External Frame of Reference Model Using Implicit Self-Concepts J. Educ. Psychol. 1–2.

[23] Wang L, 2020 Mediation Relationships Among Gender, Spatial Ability, Math Anxiety, and Math Achievement Educ. Psychol. Rev. 32 1.

[24] Wong T K Y Konishi C and Tao L 2019 A social–emotional pathway to promoting math self-concept: the moderating role of sex Educ. Psychol. 39 9 1119–1135.

[25] Reilly D Neumann D L and Andrews G 2019 Investigating Gender Differences in Mathematics and Science: Results from the 2011 Trends in Mathematics and Science Survey Res. Sci. Educ. 49 1 25–50.

[26] Parker P D Van Zanden B and Parker R B 2018 Girls get smart, boys get smug: Historical changes in gender differences in math, literacy, and academic social comparison and achievement Learn. Instr. 54 125–137.

[27] Thorson K R Forbes C E Magerman A B and West T V 2019 Under threat but engaged: Stereotype
threat leads women to engage with female but not male partners in math Contemp. Educ. Psychol. 58 243–259.

[28] Almarode J et al., 2017 Parent or guardian characteristics and talented students’ persistence in STEM Teach. Gift. Learn. STEM Subj. 1–6.

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