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Self-Identification as a STEM Person: A Gender Study among Secondary Students

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Abstract*—This study aims to compare self-identification as a Science, Technology, Engineering, Mathematics (STEM) person based on the gender of high school students. This study used a quantitative comparative research method. Data were collected through a survey about self-identification as a STEM person (N = 344), which was supported by observational data on student behavior in one class during physics lessons for seven meetings. The instrument used in this research was a questionnaire based on the STEM identity framework, which included interest (2 items), recognition (4 items), and performance-competence (6 items). Data were analyzed through means and independent samples t-tests. The results showed that there was no significant difference between male and female students in identifying themselves as STEM person. The average score for male students is 38.36, and for female students is 38.11. Based on the different test values, it was found that the [t = 0.369; p = 0.713 > 0.05] strengthened that there was no gender difference in identifying as a STEM person. However, the observation's data indicated that male students tend to be more recognized by others (i.e., peers) in terms of understanding STEM subjects, such as mathematics and science. The findings of this study unboxed the silence on the issue of gender stereotypes in Indonesia, especially in the field of self-identification as a STEM person. More explorations are needed to construct a comprehensive understanding of reducing inequality in education, especially the issue of gender stereotypes in the context of science.*

Keywords*—STEM person, STEM identity, gender, secondary students*

I. INTRODUCTION

It is common to see more women than men in higher education. However, women are a minority of students in STEM majors and three percent in information and communication technology studies [1]. This is underscored by the fact that fewer women enroll in STEM majors compared to men [2]. Students' perceptions of mathematics and science have the potential to influence the aspirations of both female and male students towards pursuing university-level STEM disciplines [3]. Literature studies by Kim et al (2018) demonstrate that female students encounter challenges of participation and inclusion within STEM environments [4]. The lack of female representation interested in pursuing STEM education results in a gender gap [5]. Gender-related achievement gaps are found to be higher in STEM disciplines than non-STEM fields at the university level [6].

In the context of Indonesia, according to OECD (2019), Indonesian female students achieve higher scores in mathematics and science than their male counterparts [7]. However, among high-achieving students, statistically insignificant differences are found concerning students' interest in engineering and science careers. This is supported by Suwono et al (2019), stating that males have more positive confidence in specific STEM fields (engineering, mathematics, technology, and STEM), whereas females hold positive confidence primarily in the field of science [8]. Another finding reveals that among new college students, females constitute a larger percentage (57.87%) compared to males (42.13%). However, the percentage of students enrolled in STEM majors in 2021 is only 36.19%, compared to non-STEM majors (42.29%), excluding education majors [9]. This discrepancy can be attributed to the association of STEM majors with male masculinity, resulting in minimal female involvement [10].

The persistence of students in STEM can be explained through the concept of self-identification as a STEM person, also referred to as STEM identity [11]. STEM identity describes an individual who perceives themselves as learners in STEM and develops an identity as someone who possesses, employs, and contributes to STEM knowledge [12], [13]. STEM identity has been proven to play a pivotal role in individual success within educational and career contexts [14]. The concept of self-identification as a STEM person is influenced by various factors. Based on explorations by Dou and Cian (2021), influencing factors include performance competence, recognition, and interest [15]. Performance competence and recognition are distinctive traits of science identity as outlined by Carlone and Johnson (2007) [16]. Interest is an intrinsic factor in an individual's attraction to STEM [17]. Hence, the development of STEM identity is considered a crucial step in supporting a successful STEM career path [18].

Research on self-identification as a STEM person related to gender has been extensively conducted,

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particularly in other countries. A study by Grimalt-Alvaro et al (2021) reveals two distinct ways individuals consider themselves as part of STEM [19]. The first revolves around a technological and engineering focus (C1), while the second centers on science (C2), with C1 being predominantly associated with male students and C2 with female students, particularly concerning their aspirations. Another study by Seyranian et al (2018) investigates STEM identity and gender differences in academic performance and development within an introductory physics course for STEM majors [20]. The results indicate gender gaps in physics, encompassing both the identification with physics and physics knowledge. Moreover, a strong STEM identity is linked to academic performance and development in the physics course, especially for females. Additional findings explore STEM identity through immersive settings, such as space camps during summer. While several group choices are available, many female students choose for astrobiology, whereas male students tend to select astroengineering and astrophysics [21]. These studies depict gender disparities in STEM identity observed in other countries (Spain, America, Canada). However, in Indonesia, further exploration of students' persistence in STEM through STEM identity is necessary. Therefore, this research aims to compare self-identification as STEM individuals based on gender in Indonesian high schools.

II. METHOD

This research aims to compare self-identification as a STEM person among high school students based on gender, making it a comparative study. A comparative study involves comparing the presence of one or more variables in two or more different samples or at different times [22]. Data collection was carried out through a survey given to 344 first-year high school students (172 male and 172 female students). The sampling was based on a proportional random sampling technique. The survey utilized a 5-point Likert scale questionnaire adapted from Dou and Cian (2021), consisting of 2 interest items, 4 recognition items, and 6 performance-competence items[15]. A pilot test of the STEM Identity instrument was conducted by Dou and Cian (2021) with a sample size of 90 individuals [15]. The Cronbach's alpha value for the STEM identity instrument was 0.98, indicating high consistency and reliability. To facilitate student understanding, each questionnaire item will be translated into proper and standardized Indonesian language. Apart from survey data, the researcher observed student behavior in a randomly selected classroom during seven physics lessons covering the topics of measurement and quantities. Survey data were analyzed using mean values, percentage scores for each item, and the difference in average self-identification scores as STEM persons based on gender using the independent samples t-test. Mean values were categorized using a measurement formula by calculating the instrument's maximum score, minimum score, theoretical mean, and population standard [23]. Meanwhile, the observation data is described in narrative form as supplementary data.

TABLE 1. CATEGORIZATION OF MEAN VALUES

No.	Mean range	Category
1	$X > 41.4$	Strong
2	$34 < X \leq 41.4$	Moderately Strong
3	$26.7\ X \leq 34$	Moderately Week
4	$X \leq 26.7$	Week

(based on the formula by Azwar, 2012)

III. RESULTS AND DISCUSSION

Description of Self-Identification as a STEM Person by Students

Self-identification as a STEM person is formed from the components of interest, recognition, and perform-competence. The mean data for self-identification as a STEM person is presented in the following Table 2.

TABLE 2. MEAN DATA FOR SELF-IDENTIFICATION AS A STEM PERSON

Gender	Mean values	Category
Male students	38.36	Moderately Strong
Female students	38.11	Moderately Strong

Based on Table 2, it can be observed that the students' mean scores fall within the moderately strong category in self-identification as a STEM person. The mean data for both male and female students are relatively similar. The following presents the percentage breakdown of self-identification as a STEM person for each item within their respective components.

Students' interest in STEM is reflected in their engagement with topics that spark curiosity and a desire to learn more. Both male and female students exhibit a higher level of curiosity compared to their interest in delving deeper into STEM subjects. Curiosity serves as a motivating factor for individuals to seek new knowledge and experiences while exploring STEM [24]. The learning experiences in subjects like science and mathematics serve as crucial opportunities for students to further explore STEM and nurture their STEM identity [25]. Students who feel comfortable learning are more likely to ask questions and engage in discussions with their peers within STEM classrooms [26].

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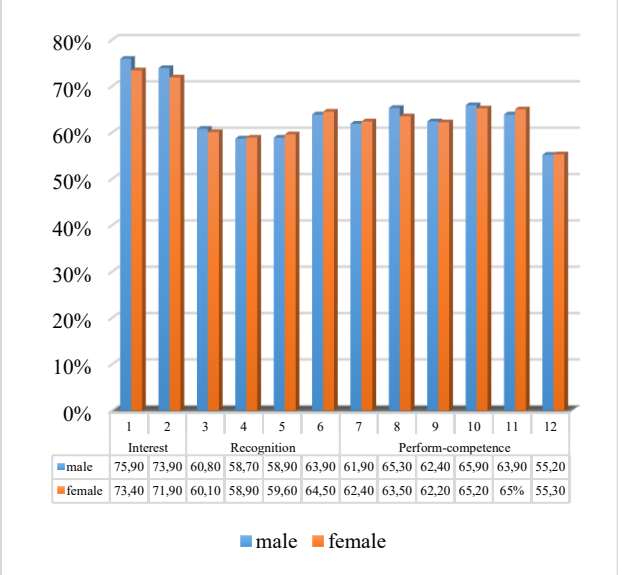

	1	2	3	4	5	6	7	8	9	10	11	12
	Interest		Recognition				Perform-competence					
male	75,90	73,90	60,80	58,70	58,90	63,90	61,90	65,30	62,40	65,90	63,90	55,20
female	73,40	71,90	60,10	58,90	59,60	64,50	62,40	63,50	62,20	65,20	65%	55,30

Fig. 1. The percentages of self-identification as a STEM person for each item

Recognition comprises self-recognition and external perspectives that acknowledge one's talent in STEM. Self-recognition as a STEM person tends to lean towards male students. Self-recognition is based on how students perceive qualities associated with being a STEM individual, such as enthusiasm for learning STEM, innovative and critical thinking abilities, and dedication to academic pursuits (Rodriguez et al., 2019). On the other hand, female students tend to emphasize external perspectives from figures like teachers, friends, and family who acknowledge their talents in STEM. External recognition is a significant contributor to identity formation [16], [28].

Performance competence is evident in students' confidence in their abilities and performance within STEM. For example, female students feel that others seek their help in STEM-related matters, male students are more confident in their STEM learning abilities, and male students believe they can perform well on STEM tests and exams. Additionally, male students express confidence in understanding learned STEM concepts, while female students are better equipped to overcome difficulties in learning STEM. Moreover, female students feel more inclined to be part of the STEM community. Demonstrating skills and knowledge in STEM is essential for strengthening one's STEM identity [29]. Mathematics and science knowledge forms the foundational basis for all STEM careers [30]. An authentic learning environment helps students enhance their communication and collaboration skills, further reinforcing their STEM identity [12]. Furthermore, students' confidence in their STEM-related abilities, particularly in STEM, can be developed through aligned learning facilities as suggested by [31].

The community plays a crucial role in shaping STEM identity (Herrera & Kovats Sánchez, 2022; Rodriguez et al., 2019). If schools or institutions providing STEM communities can facilitate students' exploration and understanding of STEM, these communities can encompass various activities, such as science laboratory internships [34], physics learning center [35], science theater [36], as well as knowledge and inquiry communities [37].

Differences in Self-Identification as a STEM Person Between Male and Female Students

The results of the significant differences test between male and female students' identification as STEM persons are presented in Table 3.

TABLE 3. T-TEST OF SELF-IDENTIFICATION AS A STEM PERSON BY GENDER

Independent sample t-test	t value	Significant
STEM person	0.369	0.713 > 0.05

These findings align with the study conducted by Dou and Cian (2021), which similarly did not show significant differences in STEM identity concerning control variables such as the level of household support for science, the language used at home, and gender among STEM students [15]. This study supports the findings of OECD (2019), suggesting that among high-achieving male and female students, there might be a similar inclination towards STEM, particularly in science and mathematics [7]. Additional observations were made during a physics class focused on measurement and quantities. Within this classroom, there were one male and one female student categorized as "talk active" students. Both students consistently engaged actively during the seven physics sessions. Their talk active behavior included engaging in discussions with peers, answering classmates' questions, seeking clarification from the teacher, and responding to questions posed in the class. During these physics lessons, the male student received recognition once from his peers. This is reflected in the following field note:

"When the teacher asked students to come forward and solve the homework problem related to unit measurements on the blackboard, he remained quiet, but his classmates pointed at him to come forward." (Session 3)

There might be alternative perspectives on this statement, but the researcher observed that the male student was highly regarded by his peers. This observation is further supported by the male student's responses on the questionnaire, where he indicated that

his classmates might recognize his talent in STEM. Recognition from others, in this context, refers to how individuals are acknowledged for their skills and abilities [27]. Even so, the results of the research we have done [38] show women as respondents who have the strongest STEM identity among other respondents

IV. CONCLUSION

The slight differences observed in the mean data support the significant difference test results, indicating that there is no significant difference in self-identification as a STEM person based on gender. Randomly selected physics classes displayed instances of peer recognition being given to a male student compared to a female student. However, this observation cannot be generalized as it might differ in other classes. While the form of self-identification as a STEM person can be influenced by various factors such as home environment, external environment, and school environment, educators should utilize diverse teaching methods to help students develop competencies. These methods could include inquiry-based learning, discovery-based learning, project-based learning, problem-based learning, and differentiated instruction [39], [40]. The designed teaching methods can also contribute to building students' STEM identity [31]. This approach is in line with the study by Munfaridah and Goedhart (2022), suggesting that teachers need to consider how positive learning experiences stimulate the development of students' identity

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