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Analyzing Student's Science Identity in Science Learning: A Survey Research

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Abstract

The exploration of students' science identity in Indonesian junior high schools is limited. However, science identity is a crucial factor in influencing students' decision to pursue a career in science. This study aims to analyze students' science identity in science learning, specifically focusing on gender differences. The survey method was used, and an instrument was adopted to measure science identity in science learning among junior high school students, utilizing a 5-point Likert scale. The questionnaire consisted of a total of 26 items, including 6 in science performance, 6 in competence, 6 in recognition scales, 6 in interest scales, and 2 open-ended questions. The research sample included 1092 junior high school students from West and East Java, Indonesia. The results revealed that there were no significant differences in the mean science identity between male and female students. However, females had slightly higher averages in science performance and competence, while males had higher recognition scores. This research contributes to the development of science identity, aiming to enhance students' learning outcomes and future careers in science. It emphasizes that science is a field that is open to both genders.

Keywords: Science Identity; Science learning; Survey research; Gender

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INTRODUCTION

Identity refers to how individuals perceive themselves in different contexts (Gee, 1998; Trujillo & Tanner, 2014). In the field of science education, identity plays a crucial role in students' engagement and achievement (Brickhouse et al., 2000). Science identity is particularly important in learning about science for several reasons. First, research indicates that it is a key factor influencing students' participation in science education. Students with a strong sense of self-awareness tend to approach learning and research with curiosity and interest, positioning themselves as scientists (Trujillo & Tanner, 2014). These theoretical assumptions are supported by empirical evidence. For instance, in their ethnographic study, Barton and Tan (2010) argued that engaging in research can encourage students to develop new ideas. Previous research has also demonstrated the significant role that science identity plays in motivating students to pursue science courses and careers in research (Aschbacher et al., 2010).

A prominent issue in science education is the underrepresentation of diverse groups in science and technology, particularly regarding gender (Brotman & Moore, 2008). In recent years, the main challenge in science education has been the declining interest among students in science and the decreasing number of students who regard science as a valuable educational path or future career (Kennepohl et al., 2009). While children generally exhibit high levels of

interest in science, research indicates that this interest tends to decline during junior high school, particularly among female students (Barmby et al., 2008). Consequently, numerous researchers have shifted their focus towards early science experiences in classrooms and informal settings in order to gain a better understanding of how students learn science (Brickhouse et al., 2000; Vincent-Ruz & Schunn, 2018).

Previous studies have yielded significant findings regarding the complex and differential role of science identity in shaping students' science choices based on gender (Vincent-Ruz & Schunn, 2018). Therefore, developing a strong scientific identity is especially crucial for girls at this age. In their work, Carlone and Johnson (2007) developed a science identity model to analyze the science experiences of 15 women of color who achieved success in their undergraduate and graduate science studies and pursued science-related careers. The results highlight the importance of recognition from others for women as they navigate three science identity trajectories: research scientist, altruistic scientist, and disruptive scientist. This study not only helps clarify theoretical conceptions of science identity, but also calls for a reevaluation of recruitment and retention strategies, shedding light on how women of color experience, interpret, and engage with science culture.

There have been many research studies conducted on students' identity in science, particularly in the United States. These studies have focused on how science identity is influenced by science interests and reflected judgments, and they have provided valuable insights into how attitudes towards science and recognition contribute to the underrepresentation of women and minorities in the field of science (Hill et al., 2018). In the American context, science identity indirectly contributes to career plans through its favorable connection with outcome expectations, although its impact is relatively minor. Additionally, science identity plays a mediating role in the connection between efficacy and outcome expectations (Ireland et al., 2018).

There has also been research conducted specifically on African American girls' engagement with science. These studies provide a better understanding of the various ways in which girls choose to engage with science and how their engagement is influenced by their perceptions of themselves as girls (Brickhouse et al., 2000).

In recent years, there has been an expansion of efforts in Singapore by social organizations, individuals, institutions, and commercial corporations to advocate for more women in science. However, these efforts are relatively restricted compared to other places like the United States and Europe (Teo & Yeo, 2017).

While significant research has been conducted in countries such as the US and Singapore, there is a lack of studies on science identity in Indonesia. On the other hand, a retrospective study has shown that gender equity in science engagement and science knowledge exists in Canadian and Australian contexts. Furthermore, consistent with previous findings for indigenous and non-indigenous students in New Zealand and Australia, we discovered that the extent to which students participate in science activities outside of school is strongly associated with variations in science engagement for both male and female students in both countries. In contrast, for Canadian and Australian students, science literacy is most strongly related to their socioeconomic backgrounds and the amount of formal time spent on science (Woods-McConney et al., 2014).

Gender equality in education has always been one of the United Nations' most important Sustainable Development Goals. Ignoring the gender gap can have long-term consequences, including the underutilization of women's roles in science, which leads to poor representation of women in STEM disciplines (Ellison & Swanson, 2010). In Thailand, the study examines the effect of gender on students' scientific reasoning ability. The findings indicate that gender has no impact on students' scientific reasoning skills for any construct (Piraksa et al., 2014). In Malaysia, researchers observed gender differences in the use of self-regulated learning strategies among science students. When the group was analyzed, the results showed no gender influence. However, within different groups of students, the results revealed that the only

significant gender difference was found in science students. Females had significantly higher self-regulatory learning than males in terms of motivation and learning strategies (Ikhwan et al., 2011). In Vietnam, the study found evidence of a gender gap, particularly among the top 500 highest achievers. Males participated more frequently and achieved higher average scores than their female counterparts (Le et al., 2023). Gender issues are complex, and it should be noted that the identified gap does not necessarily imply a failure of gender equity. Despite extensive global research, there have been few studies that explore science identity among junior high school students in Indonesia, especially considering gender differences.

The aim of this study is to fill this gap by addressing the following research questions (1) How does the profile of junior high school students' science identity in Indonesia look like?; and (2) Are there any differences in student science identity based on gender?

METHOD

Research Design

This study utilized a survey method (Creswell, 2012) that is appropriate for investigating the science identity of junior high school students in Indonesia. The data collection process involved distributing student science identity questionnaires using Google Forms to junior high school students in West and East Java, Indonesia. Data collection took place from May 3 to June 5, 2023, spanning one month.

Participants

The research included 1,092 junior high school students, consisting of 475 (43%) males and 617 (57%) females. Among the participants, 365 students were from class 7, 435 students were from class 8, and 292 students were from class 9. They were selected from 34 schools in Bandung Regency, West Bandung Regency, Cimahi, and Bojonegoro in West and East Java, Indonesia. The students' ages ranged from 12 to 15 years. Convenient sampling was employed for this study. The frequencies of the sample can be found in Table 1.

Table 1. The population and gender balance in a student sample

Grade	Gender	Number	%
7	Male	163	15
	Female	202	19
	Total	365	33
8	Male	202	18
	Female	233	21
	Total	435	40
9	Male	110	10
	Female	182	19
	Total	292	27
Total	Male	475	43
	Female	617	57
	Total	1092	100

Research Instrument

Data was collected using Google Forms for easy conversion and distribution into Microsoft Excel. The data was then analyzed using SPSS tools. The research instrument was translated from Sitong Chen and Bing Wei (2022). Cronbach's alpha was used to assess the internal consistency reliability of the student's science identity (SSI) scales. The consistency reliabilities for the science performance, science competence, science recognition, and science career interest scales were 0.80, 0.80, 0.87, and 0.84, respectively. The total scale of the student's science identity survey was 0.93, indicating high reliability. According to convention, a Cronbach's alpha of 0.80 is considered "good" (Cohen et al., 2000). The results demonstrated

that the Cronbach's alpha for each factor was above 0.80, thereby confirming the reliability of these constructs. The survey comprised 26 items, including 6 items for science performance, 6 items for competence, 6 items for recognition, and 6 items for interest, all presented on a 5-point Likert-type scale. Additionally, there were 2 open-ended questions. The Likert scale ranged from 1 to 5, representing the levels of agreement as follows: 1 (Strongly disagree), 2 (Disagree), 3 (Neutral), 4 (Agree), and 5 (Strongly agree).

Likert scales are a noncomparative scaling technique used to measure agreement levels on a 5-point scale, ranging from 'Strongly disagree' to 'Strongly agree' (Nicholls, 2010). Open-ended questions require broader thinking and elicit a wide range of responses, encouraging participants to provide informative answers (Digest et al., 1992).

The most significant advantage of open-ended questions is that they foster deeper learning. Some argue that these types of questions can help students understand a concept beyond the confines of the classroom. Open-ended questions should be intellectually stimulating, akin to a puzzle, so that students are actively engaged in seeking the answer (Robinson et al., 2019).

Data Analysis

The data was analyzed using Excel, and the data collection process involved distributing Google Forms to facilitate questionnaire completion by students and subsequent analysis using SPSS. The instrument was validated through two stages: content validity was established through expert reviews, and reliability was confirmed with Cronbach's alpha scores above 0.80 for all scales (Carlone & Johnson, 2007; Hazari et al., 2010). The average scale obtained from the data was calculated and represented as a percentage to classify the student science identity. The categories are presented in Table 2.

Table 2. Analysis of Likert Scale (Sanpanich, 2021)

Mean Score	The level of agreement
0.00 – 1.50	Very low
1.51 – 2.50	Low
2.51 – 3.50	Moderate
3.51 – 4.50	High
4.51 – 5.00	Very high

RESULTS AND DISCUSSION

Science Identity Profile of Junior High School Students in Indonesia

The survey of science identity among junior high school students in Indonesia focuses on four aspects: science performance, science competence, science recognition, and science interest. In this section, the researcher will present the findings and results of the first research question: "What is the science identity profile of junior high school students in Indonesia?" Descriptive statistics are used to illustrate these results (see Figure 1).

The average score for science performance was 3.47, indicating a moderate level of agreement. Science competence had an average score of 3.57, indicating a high level of agreement. Science recognition had an average score of 2.74, indicating a moderate level of agreement. Lastly, science interest had an average score of 3.43, also indicating a moderate level of agreement (Figure 1). Overall, the science identity of junior high school students is not very strong. The highest average score was found in science competence (3.57), suggesting that most students feel confident in understanding and applying science concepts. Science performance had an average score of 3.47, and science interest had an average score of 3.43.

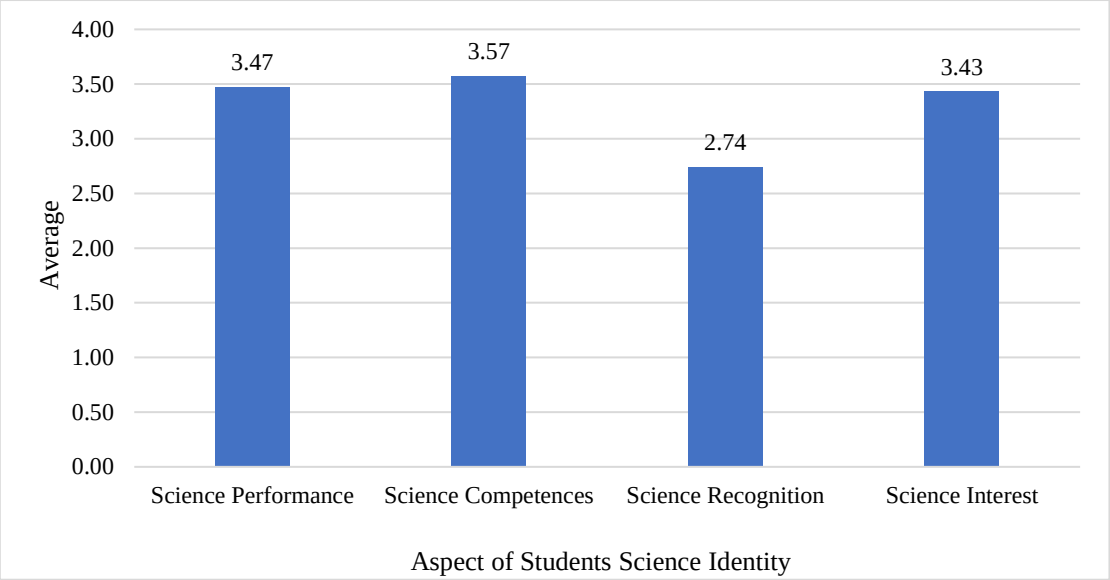

Figure 1. Average of Junior High School Students' Science Identity

Although both scores are considered moderate, there is a slight lack of interest and performance in science that could be improved. On the other hand, science recognition had the lowest average score of 2.74. This highlights the need for social support from the people around them, so that students feel appreciated for their efforts in learning science. Therefore, efforts are needed to enhance the science identity of junior high school students. This could include motivating them to develop their interest in science, recognizing their achievements, and encouraging participation in science-related extracurricular activities. These initiatives are expected to boost the science identity of junior high school students and foster a stronger enthusiasm for science.

Table 3. Average and Standard Deviation Science Performance of Junior High School in Indonesia According to Student's Science Identity (SSI) Questionnaire

Code	Questionnaire	N	Average	SD
P1	I think I did well in science classes.	1.092	3.88	0.87
P2	I can get a good grade in science subjects	1.092	3.46	0.86
P3	I can complete my science homework.	1.092	3.62	0.90
P4	I am proficient in using tools and operating apparatus in experiments.	1.092	3.27	0.88
P5	I can smoothly conduct a science inquiry activity	1.092	3.35	0.87
P6	I can get a good grade in science and technology competitions.	1.092	3.22	0.87
	Average		**3.47**	**0.87**

Table 3 provides the average and standard deviation of science performance among junior high school students in Indonesia.As shown in Table 3, the average science performance score was 3.47, with a standard deviation of 0.87. This indicates that, overall, students in Indonesia have a fairly good average science performance. However, certain survey questions, including P2, P3, P4, and P5, were found to be below the average. This can be attributed to various factors, such as a lack of understanding of science lessons, difficulty in focusing when the teacher explains concepts, inadequate learning facilities during practical classes, and a shortage of proper laboratory equipment to support science education. Despite these challenges, the majority of students enjoy studying natural science because it relates directly to their daily lives and provides a better understanding of natural phenomena in their

surroundings. Table 4 presents the average and standard deviation of science competence in junior high schools in Indonesia based on students' science identity.

Table 4. Average and Standard Deviation Science Competence of Junior High School in Indonesia according to Student's Science Identity (SSI) Questionnaire

Code	Questionnaire	N	Average	SD
C1	I think I am good at science.	1.092	3.14	0.88
C2	I can understand scientific laws and principles well	1.092	3.24	0.83
C3	I can use science to explain the natural phenomena in daily life.	1.092	3.52	0.92
C4	I believe I can learn a lot of knowledge in science classes.	1.092	4.00	0.90
C5	I believe I will do well in science.	1.092	3.86	0.88
C6	I believe I can learn even the hardest parts of scientific knowledge if I try.	1.092	3.65	0.93
	Average		**3.57**	**0.89**

According to Table 4, the average science competence score was 3.57, with a standard deviation of 0.89. This indicates that C4, C5, and C6 are above average. Students express their belief that science offers a wealth of knowledge, particularly in everyday life, and that they are capable of grasping complex concepts. However, some questions such as C1, C2, and C3 fall below the average. This is because students feel less confident in their science abilities and struggle with comprehending scientific laws and explaining natural occurrences in their everyday lives. Nevertheless, the average and standard deviation of science recognition in junior high schools in Indonesia based on students' science identity are displayed in Table 5.

Table 5. Average and Standard Deviation Science Recognition of Junior High School in Indonesia according to Student's Science Identity (SSI) Questionnaire

Code	Questionnaire	N	Average	SD
R1	I think of myself as a science person.	1.092	2.89	0.93
R2	My classmates recognize me as a science person.	1.092	2.64	1.02
R3	My science teachers recognize me as a science person.	1.092	2.74	0.93
R4	My family and friends recognize me as a science person.	1.092	2.68	0.94
	Average		**2.74**	**0.96**

The data displayed in Table 5 reveals that the average science recognition score was 2.74, with a standard deviation of 0.96. This shows that R1 and R3 are above average. Students perceive themselves as individuals who have an affinity for science, and they receive recognition from their science teachers. However, questions such as R2 and R4 fall below the average. This is likely due to the fact that their friends and family members do not view them as aspiring scientists. The lack of acknowledgment from their social circle regarding their scientific identity can impact their perceptions and experiences in the realm of science. It emphasizes the necessity of support and recognition from the social environment in shaping students' science identities. The average and standard deviation of science recognition in junior high schools in Indonesia based on students' science identity are further depicted in Table 6.

As shown in Table 6, the average science competence score was 3.43, with a standard deviation of 0.95. This indicates that questions 11, 12, and 13 are above average. Students express that science is important and can be learned anywhere because it is present in everyday life. This highlights their enthusiasm when conducting experiments and making observations. On the other hand, some questions, specifically questions 14, 15, 16, 17, and 18, fall below average. This is attributed to the lack of media and experimental tools in the classroom and lab,

which makes it difficult for students to learn science. Consequently, they anticipate difficulties if they pursue a career in the field of science.

Table 6. Average and Standard Deviation Science Interest of Junior High School in Indonesia according to Student's Science Identity (SSI) Questionnaire

Code	Questionnaire	N	Average	SD
11	I will learn more about science knowledge through a variety of sources.	1.092	3.79	0.88
12	I like to participate in various scientific activities.	1.092	3.54	0.94
13	I think the science knowledge taught in my classes is important in the real world.	1.092	3.98	0.89
14	I like the science equipment in my science classes.	1.092	3.32	1.02
15	I like to attend classes that are related to science.	1.092	3.26	0.92
16	I am interested in careers that are related to science.	1.092	3.24	0.97
17	I plan to pursue a science careers in the future.	1.092	3.14	1.06
18	I would feel comfortable talking to people who work in science careers	1.092	3.15	0.93
	Average		**3.43**	**0.95**

In general, the understanding of science identity among junior high school students in Indonesia remains unclear due to the limited research conducted in this area. However, several studies indicate that factors such as parents' educational level, family background, and interest in learning can influence the science identity of junior high school students in Indonesia. Nevertheless, the main issue that arises is the lack of opportunities for students to develop their scientific abilities due to inadequate support from both the school and the surrounding environment.

By utilizing open-ended questions regarding students' science identity, the following opinions were obtained:

> *Question 1: What are the advantages of studying science in school? Please explain your opinion.*
> *Question 2: What are the disadvantages of studying science in school? Please explain your opinion.*

"Students find science classes enjoyable and engaging, particularly when practical experiments are involved. However, they face difficulties with theoretical explanations and lack access to modern teaching aids."

When analyzing the opinions on science learning, it becomes evident that students encounter certain challenges. Student identity is closely related to their interest in science. When students have a strong science identity, their motivation to learn science also increases.

The success of learning science is influenced by both internal and external factors. Internal factors originate from the child, including aspects like health, mental well-being, intelligence, student motivation, engagement, involvement in the learning process, the structure of the learning process, and student-teacher relationships. External factors, on the other hand, are beyond the child's control and encompass elements such as family, community, friends, teachers, media, facilities, and environmental infrastructure (Jufrida et al., 2019). A study conducted by Chang and Mao (1998) examined the impact of two weeks of conventional lecture-style instruction compared to two weeks of inquiry-based instruction on the achievement of secondary students in earth science. The findings revealed that students taught through inquiry-based methods outperformed those taught through conventional lectures on an achievement exam (Gibson & Chase, 2002).Several authors have explored different ways of developing their characters' identities, but ultimately the outcome remains the same. The science identity can be determined by four main components: problem-solving skills,

enjoyment of science, self-efficacy, and science-related angst (Shein et al., 2019). This study is also centered around the significance of science identity and its connection to academic success, specifically using the science identity model (Carlone & Johnson, 2007).

The science identity model was among the first to shed light on how students identify themselves within science-related fields. Through their qualitative study of women of color in science, Carlone and Johnson (2007) developed a science identity model that consists of three intertwined aspects: competence, performance, and recognition. Competence refers to an individual's understanding of scientific content, while performance pertains to their ability to comprehend and apply scientific practices. Ultimately, recognition, both from oneself and from others, is hinged on the belief that students view themselves as active contributors to scientific knowledge and that others acknowledge their capabilities in doing so. The aspect of recognition was found to be particularly crucial for women of color in establishing their science identity.

Research by Muhlisin et al. (2019) indicates that many students struggle with comprehending scientific concepts and perceive them as complex and irrelevant to their daily lives. However, some students exhibit a strong interest in science and derive happiness from engaging with the subject matter. Additionally, involvement in science competitions or olympiads has been shown to enhance the science identity of junior high school students in Indonesia (Setyawan et al., 2021). Participation in such competitions provides direct exposure to the world of science, fostering the development of a child's scientific identity. However, further research is necessary to gain a more comprehensive understanding of the science identity of junior high school students in Indonesia.

Gender-based differences in student science identity

Using SPSS to analyze each aspect, the differences in student science identity based on gender are summarized in Table 7.Frequently use past tense: While females showed slightly higher averages in science performance and competence, males had higher recognition scores. However, the overall difference in science identity between genders was not significant (Table 7). This means that when students have high scientific identity, encouragement to study science is also high. After reviewing the results of this study, as well as the results of previous studies, it is clear that the science identity of Indonesian students needs to be strengthened. The gender difference, which has been confirmed in this study, is a factor that must be considered for the process of increasing a person's identity to be more efficient and effective.

Table 7. Non-parametric analysis by using SPSS

Component		Male Students	Female Students
Participant		475	617
Mean		3.35	3.36
Mean of Rank		539.03	552.25
Sum of Rank		256037.00	340741.00
SD		0.999	0.992
Mann-Whitney U		142987.000	
Asymp. Sig. (2-tailed)		0.492	
Normality Test (Kolmogorov-Smirnov)	Sig.	0.000	0.001
	Interpretation	**Not Normal**	

Emphasizing the importance of a person's identity in their learning and career in the field of education is key to achieving this. However, the average science identity of junior high school students by gender is shown in Figure 2.

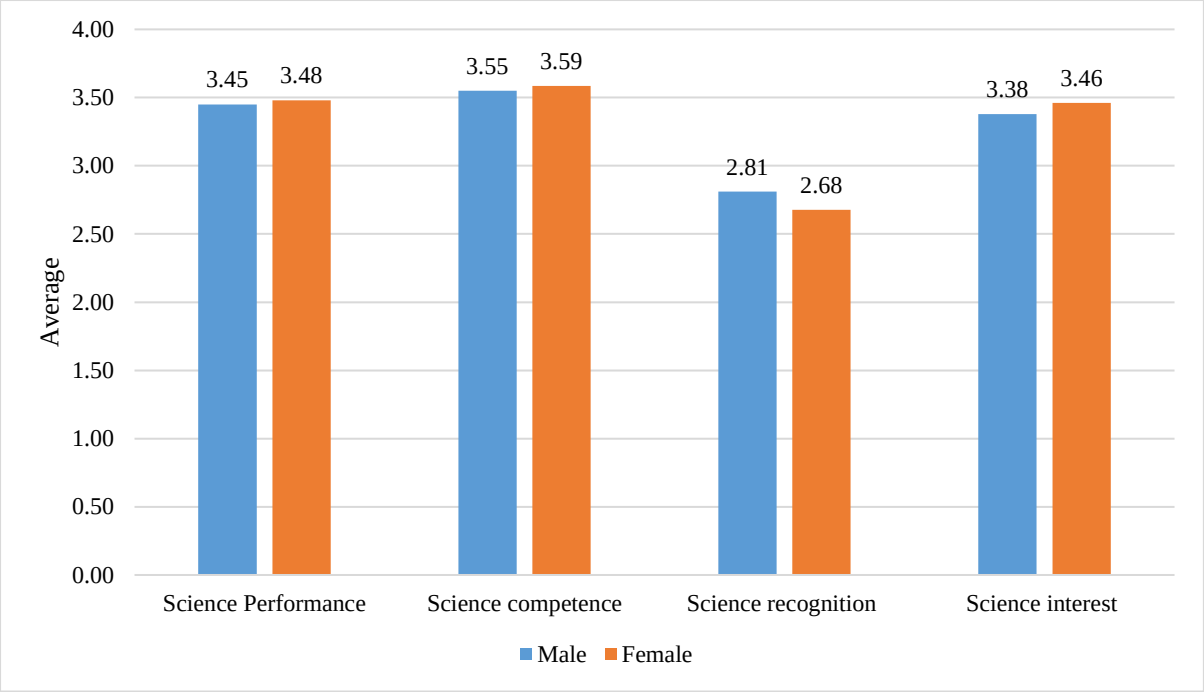

Figure 2. Average of Junior High School Students' Science Identity

The survey results show that each category scores between 2.68-3.59 on a scale of 5. In terms of science performance, females have the highest average score of 3.48, while males have an average score of 3.45. Meanwhile, in terms of science competence, females have the highest average score of 3.59, while males have an average score of 3.55. Moving on to science recognition, males have the highest average score of 2.81, while females have an average score of 2.68. In the aspect of science interest, females have the highest average score of 3.46, while males have an average score of 3.38. Although there are some variations between genders in terms of science identity, overall, there is no significant difference between the mean science identity of male and female students in junior high school.

Previous studies have shown significant differences in the science identities of male and female students, with females tending to have lower levels of scientific identity compared to males. This may be attributed to negative stereotypes about women's abilities in science and the lack of social support in these fields (Barmby et al., 2008). In contrast to Barmby et al. (2008), our study found no significant gender differences in science identity among junior high school students.Based on the improved clarity and flow, the text reads as follows:

The findings indicate that male and female students have different identities in science. Male students generally identify more strongly with science than female students (p 0.05). Male pupils also self-assess their abilities more highly than female students (p 0.05) (Taufiq et al., 2020). It is important to note that these survey results are specific to the population of junior high school members at the time and cannot be generalized to the entire population of women or the people of Indonesia in general (Hadianti et al., 2019). Research suggests that males often have stronger self-esteem than girls, particularly in terms of academic prowess. Furthermore, it is noted that boys "tend to have a stronger sense of identity and are more likely to identify themselves by their achievements and status" (McLean 2017).

It is essential to acknowledge that every person has a unique skill for developing their identity, and generalizations based on gender are not always accurate for all individuals (Galliher et al., 2017). Science identity positively influences the likelihood of pursuing a career in science and acts as a mediator for other factors that impact academic success. This sheds light on how a person's identity can guide their behavior to elevate their position within different institutional domains (Stets et al., 2017). Men generally have stronger science identities and higher views of their self-efficacy as scientists compared to women. How

individuals perceive themselves and identify as scientists can impact their motivation, persistence, and engagement in STEM areas. Increased engagement in scientific practices, such as problem-solving, critical thinking, and the application of scientific concepts, is often associated with higher levels of self-efficacy and stronger science identities (Williams et al., 2018).

CONCLUSION

Based on the results and discussion, it can be concluded that student science identity among junior high schools, based on gender, is not significant. Although females showed slightly higher average science performance and competence, males had higher recognition scores. Considering the advantages and disadvantages of learning science in junior high school, students find learning science enjoyable and interesting, especially when it involves practical experiments. However, they struggle with theoretical explanations and the lack of modern teaching aids. Nevertheless, students' science identity is crucial for improving learning outcomes and their future careers in science. Science learning needs to be presented in an engaging manner with adequate teaching and learning aids. Therefore, further research on student science identity from various regions in Indonesia is necessary.

RECOMMENDATION

This study suggests that students' science identity based on gender should emphasize that science is a field that is open to all genders and can be enriched through the formation of science clubs and involvement of parents.

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