Science identity and stem career interest among Indonesian high school students

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Abstract
Currently, relatively few high school students choose science-related fields, which may influence their future career decisions in science and STEM disciplines. Therefore, this study aimed to examine the construction of science identity among high school students and investigate its relationship with students' interest in Science, Technology, Engineering, and Mathematics (STEM) careers. A quantitative research approach was employed involving 731 students from a public high school in Malang, Indonesia. Data were collected using a science identity questionnaire consisting of 24 items and a STEM career interest questionnaire consisting of 44 items. The data were analyzed using inferential statistical analyses, including Pearson Product-Moment correlation, independent sample t-tests, and the non-parametric Mann–Whitney test. The findings revealed a positive relationship between science identity and students' interest in STEM careers, indicating that students with stronger science identity tended to demonstrate greater interest in pursuing STEM-related careers. The results also showed significant differences in science identity and STEM career interest between Grade 10 and Grade 11 students, with Grade 11 students demonstrating lower average scores. However, no significant differences were found between male and female students. These findings highlight the important role of science identity in supporting students' motivation, engagement, and interest in STEM-related learning and careers. Furthermore, this study contributes empirical evidence regarding science identity and STEM career interest among Indonesian high school students, particularly across grade levels and gender perspectives. Future research is recommended to involve broader participants from different regions and educational levels to strengthen the generalizability of the findings.

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1. Introduction

Despite Indonesia's large student population, its achievements in science at the international level remain relatively low. According to data from the Programme for International Student Assessment (PISA) conducted by the Organisation for Economic Co-operation and Development (OECD) in 2022 and released in 2023, only around 5%–6% of Indonesian students achieved level 5 or 6 proficiency in science. This figure is still below the OECD average of 7 (OECD, 2023). Proficiency levels 5 and 6 in PISA reflect high-level scientific thinking skills, such as formulating hypotheses, designing experiments, critically evaluating evidence, and applying scientific knowledge in novel contexts. The low proportion of Indonesian students reaching these levels highlights ongoing challenges in science education, including the quality of instruction, curriculum design, and supporting facilities. Contributing factors include the limited use of inquiry-based learning approaches, insufficient teacher training in science pedagogy, and suboptimal implementation of authentic assessments. Consequently, systemic reforms in science education are necessary to improve students' scientific competencies (OECD, 2023).

Moreover, Indonesia's performance in science has declined. In 2015, the average PISA science score was 403, but this dropped to 396 in 2018 (Tohir, 2019). Meanwhile, students who demonstrate greater persistence in learning science and have stronger intentions to pursue science-related careers in the future indicate a strong science identity (Aschbacher et al., 2010). Thus, the decline of Indonesian students' performance in science becomes a problem in their science identity development.

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Science identity plays a key role in how individuals integrate science into their self-concept and daily lives, particularly in influencing their interest in STEM careers (Stets et al., 2017). Although the importance of science identity in science education is well recognized, evidence shows that students' science identity remains low. In the western context, represented by the United States, only 38% of 1,502 teenagers identified themselves as "science people"(Fraser et al., 2014). This condition might also happen in the context of Indonesia, since Indonesia has a low performance in science. Developing students' science identity should be an integral part of science education, also in physics instruction. However, this focus is still rarely found, and research on students' science identity levels in Indonesia remains limited, particularly studies aimed at developing science identity.

In addition, science identity is a crucial factor influencing students' science performance. It reflects how students perceive themselves in relation to the scientific community whether they feel competent, recognized, and interested in science (OECD, 2019). A previous study by (Maula et al., 2024) revealed that Indonesian students' science identity is still in the developmental stage, suggesting that many students lack confidence in seeing themselves as part of the scientific community. This low science identity is correlated with the country's weak science performance, as also reported by (OECD, 2019). Students with weak science identity often exhibit low self-confidence, lack motivation, and show limited engagement in learning science deeply.

Students with a strong drive to learn science are more likely to have a strong science identity. Among adolescents, science identity is also shaped by the kinds of games they play especially problem-solving and science-related games, which have been identified as strong predictors of science identity (Fraser et al., 2014). Furthermore, students' science identity is influenced by geographical context and the type of educational institution they attend. Previous studies show that students in urban areas tend to have stronger science identities than those in rural settings. Similarly, students from private schools report higher levels of science identity compared to their peers in public schools (Vincent-Ruz & Schunn, 2018). In the Indonesian context, previous research also found significant gender-based differences in science identity, with male students reporting stronger science identities than female students (Hidayat, 2022). This disparity reflects lower self-confidence among female students regarding their scientific knowledge and abilities. However, the gender differences were only significant in specific components, namely science-related feelings and self-efficacy (Hidayat, 2022). Addressing gender differences is essential for enhancing science identity development in a more efficient and equitable manner. This is particularly important considering that science identity influences not only students' learning outcomes but also their future career paths in science.

Science identity plays a vital role in shaping individuals' interests, knowledge, and engagement with science. It refers to how students perceive themselves, the extent to which they believe in their scientific abilities, and what they aspire to achieve in relation to the scientific world (Chen & Wei, 2022). Students with a strong science identity view science as a means of solving real-world problems and actively participate in the learning process with a scientific mindset. Such engagement is reflected in high curiosity, enthusiasm for exploring scientific concepts, openness to diverse perspectives, perseverance in facing challenges, and effective communication in scientific contexts (Kim, 2018). This study seeks to provide an initial overview of science identity among Indonesian high school students, particularly in relation to gender. Moreover, the findings are expected to offer insight into how science identity is closely tied to students' STEM career interests and gender, thus informing strategies to improve science education and better prepare students for future careers in science. Although previous studies have examined science identity, most studies have primarily focused on science achievement, self-efficacy, and science literacy, while limited attention has been given to the relationship between science identity and STEM career interest among Indonesian high school students. In addition, studies examining science identity across grade levels and gender perspectives in the Indonesian context remain limited. Therefore, further investigation is needed to provide empirical evidence regarding how science identity relates to students' interest in STEM-related careers and how these patterns differ across grade levels and gender. This study is expected to contribute to the development of more inclusive and supportive science and physics learning environments that strengthen students' science identity and STEM career aspirations.

2. Literature Review

2.1. Science Identity

Science identity can be defined as being "a certain kind of person" in a specific context(Gee, 2000). One study illustrates that the three dimensions of science identity competence, performance, and recognition overlap. A person with a strong science identity sees themselves as capable in science and is also perceived that way by others. This can be reflected in several factors, such as conducting scientific research, identifying oneself as "a science person,".

Science identity can be influenced by gender, race, and ethnicity. Several studies have shown that females tend to have lower self-confidence regarding their science identity (Hidayat, 2022). Science identity is not only about what individuals say about their relationship with science or their engagement in it; it also arises situationally and may persist over time. It becomes tangible when one's performance in science is recognized by others, which affirms their place as someone knowledgeable in science.

One key aspect of science identity is being recognized as a scientist. However, stereotypes persist such as the image of scientists being white males which continue to shape who is seen as "belonging" in science (Chen et al., 2021). Therefore, reinforcing science identity remains important, especially for minority groups such as women and people of color, who are often underrepresented in science (Rodriguez et al., 2017). Having a science identity means one sees themselves as part of the science community and believes others recognize this as well.

This understanding of science identity offers insights into how individuals perceive themselves as "science people," but it also illustrates that each construction of science identity may differ depending on the context. Understanding these contextual contributions is critical to grasping the complex nature of science identity (Hazari et al., 2017).

Science identity is a crucial aspect in science education research for several reasons. First, it has been shown to significantly influence students' participation in science learning. Students with strong science identities often exhibit high motivation and curiosity in science, enabling them to position themselves as scientists (Trujillo & Tanner, 2014). Second, empirical studies have revealed links between science identity and long-term positive outcomes, such as persistence in science disciplines (Aschbacher et al., 2010) and intention to pursue science-related careers (Hazari et al., 2010). These findings suggest that science identity has broad effects on student engagement and beneficial learning outcomes(Arizaga et al., 2016).

Science education research (Calabrese Barton et al., 2013) has sought to fill conceptual gaps and gain a deeper understanding of how students construct their identities in relation to science (Carlone & Johnson, 2007) by developing a model of science identity based on case studies of scientists. This theoretical framework incorporates three overlapping components (Gee, 2000). First, competence, which reflects the ability to understand scientific content and concepts. Second, performance, which refers to socially recognizable enactments of scientific practices in public or cultural contexts. Third, recognition, which occurs when individuals see themselves or are acknowledged by others as members of the science community (Carlone & Johnson, 2007).

This reflects a deep engagement in understanding scientific concepts, accompanied by a high level of intrinsic motivation to explore knowledge through scientific inquiry. Students with such characteristics also tend to possess the necessary skills to demonstrate their competence, such as the ability to answer questions in Grade, operate laboratory tools and instruments, apply scientific principles to problem-solving, and achieve optimal results in learning assessments, including examinations (Chen & Wei, 2022).

At the next stage, they will achieve recognition by recognizing themselves as scientists and gaining recognition from others, such as science teachers, Grademates, and family, for participating in scientific research (Carlone & Johnson, 2007). Theoretical framework can shown a Figure 1.

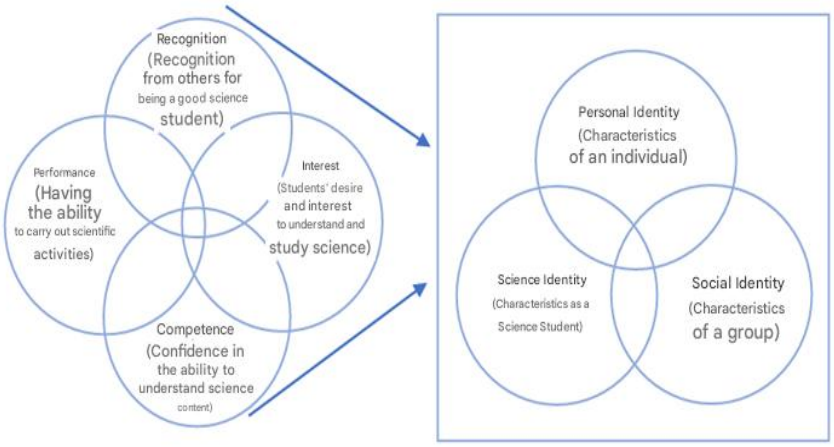


Figure 1. Theoretical framework

In Indonesia, research on science identity in students is still very limited, especially how to develop science identity. The limited research on science identity makes it difficult to describe the level of science identity of students in Indonesia. Knowing and then developing students' science identity should be one of the important agendas in Science Education (Hidayat, 2022). The possibility of the low proportion of graduates in the STEM field in Indonesia, which was recorded only around 19.42% in 2018, can be caused, among others, by the lack of attention to the development of science identity in students from an early age (Antara, 2022).

A study on science identity that exists in students consists of several components including, the competency component of students who have the belief that they have the ability to understand science. In the performance component, students believe that they are able to work on tasks or jobs in the field of science. In the recognition component, students recognize themselves as a scientist and believe that others also recognize this. In the interest component, students have curiosity to think and study science (Hidayat, 2022).

The higher students' science identity, the more likely they are to enter science jobs, the higher students' science identity advantage, the more likely they are to enter science jobs, the more positive students' science identity gap, the less likely they are to enter science jobs, the more negative students' science identity gap, the more likely they are to enter science jobs (Hidayat, 2022).

2.2. Science in High School

Some studies suggest a progressive decline in science identity or interest in girls compared to boys, which directly parallels the lower number of educational opportunities and science experiences that girls experience (Bleeker & Jacobs, 2004). The decline in science identity or interest in science is most drastic in early secondary school (Potvin & Hasni, 2014). Female students in high school experience fewer opportunities to engage in science Gradees, compared to male students (Patall et al., 2018). The percentage of female students who believe that males have superior abilities compared to females in the field of mathematics has increased significantly, from 15% when they were in grade IX to 25% when they were in grade XI (Sansone, 2019).

Education before middle school often concerns everyday topics, such as interests that can be acquired from anyone in life. However, starting from secondary school, science education emphasizes scientific goals that are gradually contextualized from everyday interests. The majority of students are unable to spontaneously develop an appreciation for the scientific purpose behind science learning and often rely on school teachers to foster this appreciation (Anderhag et al., 2013). Without this appreciation, students may feel excluded from science even if they perform well in science subjects (Archer et al., 2015). However, in a study of women who chose careers in STEM, most of them said that their interest in science emerged during middle school (Ivie, 2006). Thus, middle school can be considered as a critical period where the bifurcation between genders in science identity (Hazari et al., 2010).

In addition to a developmental or identity-based approach, to address the issue of interest in S&T by controlling for development depends "on the quality and type of instruction" (p.35) provided to students at school (Krapp & Prenzel, 2011). Based on a review of more than 100 references, it was found that as students transition from primary to secondary education, their interest in science tends to decline significantly. Many students no longer see science as a relevant option for their future or as part of their aspirations for success (Christidou, 2011).

2.3. STEM Careers (Science, Technology, Engineering, Math)

There are various factors that can discourage students from pursuing STEM careers, including lack of adequate preparation in math and science subjects in the education system, limited access to technology, lack of mentorship from experts in STEM fields, and psychological barriers, such as the view that math and science are too difficult and challenging (Drew, 2011). Research involving in- and out-of-Classroom interventions aimed at connecting underrepresented students with STEM professionals and careers shows promise for increasing students' understanding and interest in these career pathways (Avery, 2013). The implementation of role model-based interventions in STEM fields has shown positive impacts in increasing student engagement and strengthening their understanding of STEM concepts, particularly at the secondary school level (Ashby Plant et al., 2009).

Another reason why students may not be interested in STEM careers is due to the perception that these careers are too difficult and require considerable study time (American Association of State Colleges and Universities, 2005). Some research also suggests that STEM interests may differ between male and female students, with male students being more interested in physics and engineering and female students being more interested in biology (Baram-Tsabari et al., 2009). From this, it can show that social roles and gender also play a role in students' career interest efficacy.

A survey found that elementary school students most often described Engineering professions as male-dominated (Capobianco et al., 2011). During the high school years, students consistently perceived engineering as a male-dominated profession, involving jobs such as automobile maintenance and construction, boat operation, electronics repair, and general design work (Capobianco et al., 2011). Post-secondary students generally perceive careers in information technology (IT) to be less collaborative and monotonous as scientists and Engineering (Thomas & Allen, 2006). These careers may not appeal to students, particularly female students due to their marketing strategies (e.g., male-only environments, long working hours that are not conducive to families) (Johnson & Miller, 2002). It is strongly recommended that these specialized professions be explained more clearly to students to attract more people (Kier et al., 2014a).

2.4. Science Identity and its Relation with High School's Students Career Choice

In recent years, major concerns in science education have focused on students' low interest in science and the declining number of students who see science as an important field for their future or as a basis for future career development (Kennepohl, 2009). Although students generally show a high level of interest in science, findings suggest that this tends to decline as secondary school progresses, particularly among female students (Barmby et al., 2008). Therefore, many researchers pay special attention to students' experiences in the context of science learning, both inside and outside the Classroom, in order to gain a deeper understanding of the process of science identity formation (Barton & Tan, 2010).

Science identity can have far-reaching effects on student engagement and beneficial outcomes in science learning. As we know, for many students, adolescence is an early period when their interest in science is not yet fully heightened (Barmby et al., 2008). This can be influenced by significant physical, emotional and social growth. During this period, students' developmental and cognitive changes will increase their awareness of science interests. In addition, high school age is a time when students begin to form their career aspirations, which predict academic achievement, and future careers, especially for those interested in science (Tai et al., 2006). Thus, it is important to examine students' science identity during this period in high school.

3. Method

3.1. Research Design

The research design applied in this study is a quantitative approach. The quantitative approach allows researchers to collect data in the form of numbers which are then analyzed using statistics, relying on instruments that are prepared beforehand (Creswell & Creswell, 2017). This study has two main aspects of variables, namely the independent variable science identity (X) and the dependent variable STEM career (Y).

3.2. Participants

The subjects in this study consisted of X and XI grade students in one of the public high schools in Malang. The number of respondents reached 731 students from the junior high school level, with data distribution shown in Table 1.

Table 1. Description of Research Respondents

Grade	Gender		Average age
	Boys	Girls	
X	149	196	15 years old
XI	167	219	16 years old
731 Students			

3.3. Data

Data were collected through questionnaires that had undergone validity and reliability testing prior to administration. The instruments consisted of a 24-item science identity questionnaire adopted (Chen & Wei, 2022) and a 44-item STEM career interest questionnaire adapted from (Kier et al., 2014b). Instrument validity was evaluated through item validity testing and expert judgment. The results indicated that all questionnaire items were valid, as evidenced by r-count values exceeding the r-table value (0.329) and significance values below 0.05. In addition, the reliability analysis showed that both instruments demonstrated good internal consistency. The questionnaires used a five-point Likert scale ranging from Strongly Agree to Strongly Disagree.

3.4. Data Analysis

The data for this study were collected through the distribution of surveys focusing on science identity and career interest in STEM fields This study involves two variables, namely the independent variable (X) science identity, which affects the dependent variable (Y) STEM career interest.

This research involves several techniques applied by the researcher. Before starting data collection, researchers first conducted instrument prerequisite tests, which included validity and reliability tests. After that, researchers continued with the independent sample t-test for data that met the assumptions of normality and homogeneity. For non-normal data, researchers used a non-parametric test, namely Mann-Whitney. The instruments used in this study include measuring instruments for the independent variable, namely science identity, as well as measuring instruments for the dependent variable, namely STEM career interest.

4. Results and Discussion

4.1. Overview of Science Identity in High School

The results of this study are described referring to the grade level and also the gender of the students. The description of science identity can be seen in Table 2.

Table 2. Overview of science identity in high school

No	Grade	t_{Count}	t_{table}	Significance value	0.05	Is there/Isn't a difference
1	X With XI	1.246	2.331	0.213	0.05	No

Based on the results of the independent sample t-test, a significance value of 0.213 is obtained which is greater than 0.05, as well as a t-count value of 1.246 which is smaller than the t-table value

at 729 degrees of freedom, which is 2.331. This shows that there is no significant difference in the average science identity between Grade X and Grade XI students. Thus, it can be concluded that both groups have similar average science identity.

This identity develops through the process of interaction with other individuals, so it inherently has a social nature (Kim, 2018). Based on the data analysis conducted, there is a tendency to decrease the science identity score. Experiences gained in science learning, such as interactions with Grademates and teachers, can influence and potentially shape science identity (Kim, 2018). Looking at the results of the science identity picture above, we can improve by means of a multi-representation approach that has the potential to develop students' science identity at a higher education level as said by (Munfaridah & Goedhart, 2022).

Furthermore, the results of the analysis show that there are differences in the average science identity of students in Grade X and Grade XI as presented in Table 3.

Table 3. Mean Science Identity

No	Grade	Average		There is/isn't difference
		X	XI	
1	X With XI	3.47	3.38	Yes

One of the contributing factors is the transition phase from junior high school to senior high school, where in this phase the characteristics formed in junior high school are often still carried over and affect students when entering high school (Kusdiyati et al., 2011).

Students experience a shift in social position within the school environment known as the top-dog phenomenon, which is when they move from the highest position as final year students in elementary school to the lowest position as new students in junior high school or high school (Elizabethalia et al., 2023). As students enter higher education, their interest in science tends to decline (Cheung, 2018). This transition process is often a challenging period for many students. The change from grade X to grade XI involves a shift from a smaller, more personalized structure to a larger, less familiar environment. In addition, there is a shift from a single-teacher to multi-teacher dominated teaching system, from a more homogeneous to a more diverse peer group, as well as increased pressure to achieve higher academic performance (Setiawati, 2016).

Positive adjustment in the school environment seems to be related to the lack of influence from peers who show negative behavior towards individuals. Conversely, poor self-adjustment tends to arise when individuals are in a social environment where negative peer behavior plays a significant role (Kusdiyati et al., 2011). Science identity scores in Grade X students tend to be stronger than those in Grade Xi (shown in Table 3.) This is due to the views of Grade X students who tend to be more similar to their views on science in junior high school. Meanwhile, in Grade XI, the view of science is considered more complex and requires a longer adaptation process, which leads to a decrease in the tendency of science identity. This fact is also supported by data showing the number of grade XI students who choose not to take science specialization.

Science identity is related to gender (Hill et al., 2018). The results of this study showed no significant difference between male and female science identity for each grade level. The distribution of students' science identity scores based on gender can be seen in Table 4.

Table 4.Overview of Science Identity in High School and its Relationship with Gender

No.	Grade	Significance	0.05	There is/isn't a difference
1	X Boys with X Girls	0.661	0.05	No
2	XI Boys with XI Girls	0.969	0.05	No
3	X Boys with XI Boys	0.277	0.05	No
4	X Girls with XI Girls	0.376	0.05	No

By looking at the results of this study, as well as the results of previous studies, Indonesian students' science identity needs to be improved (Hidayat, 2022). This can be attributed to the findings of the OECD (Organization for Economic Cooperation and Development) which says that low

science literacy and student interest in science in Indonesia (OECD, 2019). Because when students' science literacy is low students' science identity tends to decrease. Because science literacy and science identity are interrelated. The results of previous studies that discuss gender, the results are significantly different. Male students' science identity levels appear stronger than female students (Hidayat, 2022). This shows that women have less confidence than men in their knowledge and abilities in science. However, in terms of its components, their identity is only significantly different in the components of feelings of science and self-efficacy (Hidayat, 2022). In general, male students show a higher science identity than females, they are more confident that they are suitable and capable in the field of science. However, this does not mean that women are not capable, but lack confidence, especially in STEM fields that are often stigmatized for men. Of all the components of science identity (competence, performance, recognition, interest), the only ones that really differ are feelings towards science and self-efficacy or confidence in oneself to understand science.

However, in this study, there was no significant difference between male and female science identity. This may be due to the dominance of the number of female students in the Grade far more than male students. Another factor that may be the cause is that in Indonesia, women are a majority and have a strong religious background so that their recognition is very good, causing a strong science identity, so there is no difference between men and women. As stated by (Moshfeghyeganeh & Hazari, 2021), physics and gender identities intersect in majority muslim countries as opposed to what has been found in the West which is because of religion.

4.2. Overview of STEM Careers in High School

STEM careers in high school do not show any significant differences by grade level. This can be seen in Table 5.

Table 5. Overview of Science Identity in High School

No	Grade	t_{Count}	t_{table}	Significance value	0.05	There is/Is no difference
1	X With XI	-0.024	2.331	0.838	0.05	No

Although schools provide STEM-related knowledge experiences and encourage career aspirations, there is a lack of support for career exploration, especially in terms of providing structured and detailed information about specific professional pathways. This inhibits students from broadening their horizons, particularly regarding future careers directly related to STEM fields (Drymiotou et al., 2021). Furthermore, (Drymiotou et al., 2021) state that STEM learning in schools should focus on practical applications, containing scientific topics related to everyday life so as to support students' career interests in STEM fields. The current application of the STEM approach at the high school level is still partial, which is generally limited to learning strategies in the Classroom. The approach has not been integrated as a whole in the form of holistic STEM education, which includes curricular, intracurricular, and extracurricular aspects in an integrated manner.

In Indonesia, the application of STEM education is still limited to the use of approaches in the learning process. This is reflected in Curriculum 2013, which only focuses on science and mathematics subjects, while technology and engineering are still placed in a minor or even non-existent position (Winarni et al., 2016). However, this does not mean that STEM education cannot be implemented in Indonesia. By using an integrated or embedded STEM curriculum model, STEM education can still be integrated without changing the existing curriculum structure (Winarni et al., 2016). Therefore, there is an opportunity for students at the high school level to gain experiences that can help them understand career interests in STEM fields. However, different results were found in this study, where students struggled to relate the STEM subjects learned at school to their real life. As a result, only a small percentage of students have a deep understanding of STEM careers (Drymiotou et al., 2021).

Students' career choices in STEM fields and the related activities they participate in to plan for the future also influence their intentions to pursue careers in these fields. Research shows that positive attitudes towards science that emerge from around 10 years of age tend to decline significantly when students enter 14 years of age, which is in the general age range of junior high school students (12-14 years) (Blotnicky et al., 2018). There was no difference in average STEM career interest among junior high school students. This finding is consistent with a study involving

24,000 middle and high school students, which showed that career intentions change significantly between grade 9 and grade 11, i.e. from grade 9 middle school to grade 11 high school.

This indicates that intentions and motivation towards STEM are strongly influenced by time (Blotnicky et al., 2018). At the junior high school level, students may not yet be fully aware of the challenges in their preferred subjects. However, as they make the transition to high school, many begin to change their outlook and career goals. For high school students, career planning becomes an important long-term program, as their decisions in determining the next level of education, such as choosing a study program at university, are greatly influenced by such planning (Haryanto, 2018). High school students, when determining the direction of education to be taken, should consider the relationship between their choices and the world of work or the career they dream of (Haryanto, 2018).

Furthermore, recent studies emphasize the importance of implementing more explicit interventions in STEM career development. However, at the lower secondary education level (junior high school), available intervention programs remain relatively limited. Approaches related to career awareness in STEM fields are generally introduced at the upper secondary level (senior high school), often through outreach activities facilitated by guidance and counseling teachers to help students develop an interest in science and gain a more concrete understanding of career prospects in the field (Drymiotou et al., 2021). Providing support for teachers by ensuring access to adequate educational resources enabling them to participate in collaborations between schools and industry, as well as facilitating student interaction with STEM role models is considered a highly strategic and crucial step (Drymiotou et al., 2021).

Previous research indicates that triggering situational interest within Classroom learning contexts can be an effective approach to initiating the development of long-term interest in students (Palmer et al., 2017). Efforts to introduce curriculum changes and to enrich both formal and non-formal educational activities are aimed at creating engaging and personally meaningful learning experiences in the context of science and technology within the school environment. In addition, emphasizing the importance of collaboration between schools and industry also contributes to fostering students' interest in pursuing careers in STEM fields (Drymiotou et al., 2021). STEM career orientation in senior high school also does not show significant gender differences. The distribution of students' STEM career scores is presented in Table 6.

Table 6. Gender-Based Distribution of STEM Career Scores

No.	Grade	Significance	0.05	There is/isn't a difference
1	X Boys with X Girls	0.451	0.05	No
2	XI Boys with XI Girls	0.757	0.05	No
3	X Boys with XI Boys	0.707	0.05	No
4	X Girls with XI Girls	0.092	0.05	No

Their low interest in pursuing a career in STEM may not only be due to self-perceptions that lead them to feel lacking in the skills or competencies required for engaging in science-related activities. Globally, there is a significant gap between the number of graduates in science, technology, engineering, and mathematics (STEM) and the workforce demands in these sectors. The number of STEM graduates with adequate skills remains insufficient to meet the growing demand for jobs in this field (Peterson et al., 2015).

Another reason why students may not be interested in STEM careers is the perception that these careers are too difficult and require a lengthy period of study (American Association of State Colleges and Universities, 2005). A number of research findings indicate gender-based differences in interest toward STEM fields. Male students tend to show greater interest in physics and engineering, while female students are more inclined toward disciplines such as biology (Baram-Tsabari et al., 2009). This suggests that social roles and gender also play a role in shaping students' career interest self-efficacy.

4.3. Since Identity and Its Relation to STEM Career Choices

The results of this study are described referring to the grade level and also the gender of the students. The description of science identity can be seen in Figure 2.

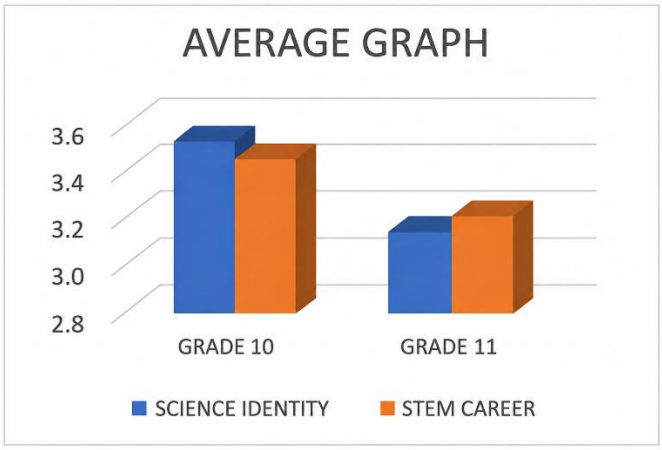


Figure 2. Graph of the average relationship between science identity and STEM careers in Gradees X and XI

Based on the graph, it can be concluded that science identity is related to various positive outcomes experienced by students in the future, such as perseverance in exploring scientific disciplines and the desire to pursue a career in science. Students who have a deep and meaningful understanding of science materials, accompanied by an instrinsic motivation to understand the world through a scientific approach, can be categorized as individuals with a strong science identity. This identity is reflected in their active involvement in the science learning process and appreciation of scientific values and ways of thinking. In addition, they also have the necessary skills to demonstrate their competence in various activities, such as answering questions in Grade, completing assignments, operating laboratory tools and instruments, applying scientific principles to solve problems, and achieving high results in learning evaluations (Chen & Wei, 2022). Furthermore, students gain recognition by identifying themselves as individuals with scientific abilities, while the recognition also comes from others, such as science teachers, Grademates, and family members. This recognition becomes an incentive for them to grow into scientists who are actively involved in various scientific activities (Chen & Wei, 2022). By having a strong science identity, an individual has a high potential to develop career interest in STEM fields. This suggests that science identity is a key factor in the formation of STEM career interest.

Students who show high levels of science efficacy tend to have a greater tendency to choose a career path in STEM compared to students who have low science efficacy. This suggests that belief in one's ability to shape career interest in science plays the most role in shaping interest in the STEM domain, along with the development of a positive science identity. (Sahin et al., 2017). Their low interest in STEM careers may not only be due to self-perceptions that make them feel less capable or competent in doing science-related activities. It is possible that other individual or contextual factors play an important role in explaining the development of career interest in STEM (Zhao et al., 2023). Independent sample ttest result can be seen in Table 7.

Table 7. Independent Sample T-Test Results

No	Variable	Significant	Information
1	Science identity	0.213	No
2	Career STEM	0.213	No

Social identity may be one of the important factors influencing career interest in STEM (Kim, 2018). For example, an inclusive science learning platform that promotes a sense of belonging among adolescents from underrepresented groups may play an important role in preparing them to pursue careers in STEM (Zhao et al., 2023). Thus, the results of this study reinforce the understanding that students' science identity is an important factor that positively influences their engagement in learning, perseverance, and interest in a career in science (Chen & Wei, 2022). Similar research has

also shown the same for secondary school students, where their views on science are strongly related to their interest in a STEM career (Kang et al., 2019).

We often see that in high school, there are more science Gradees than social studies Gradees. This shows the high interest in the science field. However, when continuing to college, many students from science majors choose to change majors (Hapsari, 2016). This is because students choose science majors during high school because they follow the flow or influence of friends (Yulia et al., 2022). In a friendship, adolescents exchange information, which in turn can affect their future achievements (Nelissa et al., 2018). When choosing a science major in high school, many students face a reality that does not match their expectations. When studying the subjects of Physics, Chemistry and Biology, some of them find it difficult to adjust. As a result, when continuing to the next level, many students switch from their chosen majors (Akbar, 2015). There is also an assumption that students choose science majors because of the perception that science students are superior to social studies Gradees (Mu'awanah & Jacky, 2015). The stigma that still develops in society considers that children from science majors are smarter, while children from social studies majors are considered lazy. This view is a stereotype that has been ingrained in the minds of many people (Mu'awanah & Jacky, 2015). Gender differences also need to be considered so that the process of improving students' science identity can be more efficient and effective. This needs to be done by considering that students' science identity affects their learning outcomes and their future careers in science.

5. Conclusion

This study reveals the level of science identity and students' interest in STEM careers at the high school level. The results showed that students' science identity decreased from grade X to grade XI. In more detail, there is a significant difference in the average science identity score between grade X and grade XI students. A similar decline was also seen in career interest in STEM fields in grade XI students. Other findings indicated a significant relationship between science identity and students' career interest in STEM careers. So, it can be concluded that the stronger the students' science identity, the greater their connection to pursue a career in STEM. When compared to previous studies, which showed a tendency for males to have higher science identity, the results of this study suggest a positive shift towards equality in the development of science identity among adolescents, regardless of gender or education level. Thus, the results of this study indicate a potential shift in gender perceptions and experiences in science education at the high school level in Indonesia.

The analysis shows that there is no significant difference between male and female students in terms of science identity and interest in STEM careers. The low level of science literacy among students is the main factor that weakens their science identity, thus impacting their interest in science careers. Although some previous studies have shown a tendency for males to have a stronger science identity, the results of this study are different, which is most likely influenced by a more inclusive school environment, the dominance of female respondents, and increased awareness of gender equality. The findings indicate the potential for positive changes in gender perceptions and experiences in science education at the high school level in Indonesia. This illustrates that strengthening science identity can be done without having to be limited by gender factors, as long as the learning environment is able to provide equal and inclusive support.

These findings address the identified research gap by providing empirical evidence regarding science identity and STEM career interest among Indonesian high school students, particularly across grade levels and gender perspectives, which have received limited attention in previous studies. The results also contribute new insights relevant to physics learning by highlighting the importance of developing students' science identity through inclusive and supportive learning environments. In the context of physics education, strengthening science identity may enhance students' motivation, participation, and interest in pursuing STEM-related careers.

6. Implication

This study has some limitations, especially in terms of its aims and objectives. Given that the participants were high school students, it is important to provide a clear explanation of the purpose of the study as well as details about the questionnaire to be administered to them.

This study has several implications for various parties. Students need to be strengthened in understanding themselves, including their identity as individuals, their beliefs, abilities, and aspirations, especially in building science identity. Therefore, it is important to further explore science identity and career interest in STEM fields because both are key factors in shaping a young generation that is ready to face future challenges that are full of technological and scientific developments. A strong science identity not only encourages students to be more confident in learning science, but also increases their perseverance, sense of belonging, and interest in contributing to the field. Meanwhile, STEM career interests that are formed early on play a major role in determining the direction of students' future education and profession.

In addition, teachers also need to understand the concept of science identity and STEM career interest in order to design more effective learning methods such as the inquiry approach where students are actively involved in the process of investigation and experimentation to discover science concepts independently. This approach can strengthen students' science competence and performance. With this understanding, teachers can help increase students' interest in science through more appropriate learning approaches.

Furthermore, schools can utilize the results of this study as a reference in developing learning processes and curricula that encourage increased student interest in natural science (IPA), especially physics. This can be done through the integration of the STEM approach in learning science, especially physics, such as providing experiment-based project assignments, linking material to real-life contexts and providing exploration space for students to ask questions and think critically. In addition, the results of this study can also be taken into consideration in helping students plan and develop their careers in STEM fields.

Author Contributions

All authors contributed substantially to the research process, data analysis, and writing of this article, and approved the final version of the manuscript submitted for publication.

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