Women Emancipation in Indonesia: A Psychological desire to choose the field of physics education at university level

Hisbulloh Als Mustofa[1*], Muhammad Zuhdi[2]

[1]Department of Physics, Faculty of Science and Mathematics, Sultan Idris Education University, Malaysia.
[2]Physics Education Study Program, Faculty of Teacher Training and Education, University of Mataram

Abstract: The gender bias that places women as incapable people ultimately reduces their psychological drive to engage with the field of science, especially physics. This is in stark contrast to the prevailing attitudes at universities in Indonesia. This then became the basis for the aim of this research to explore whether women's interest in studying physics education was based on psychological factors in themselves by comparing them with men. The research was conducted using quantitative survey methods, and a sampling process using random sampling was carried out on the population of a university in Indonesia. The sample was divided into two groups based on gender: 77 women and 23 men. The data collection instrument was developed using the grounded theory of planned behavior (TPB) and social cognitive career theory (SCCT), which identified four main psychological factors: identity, interest, self-concept, and self-efficacy. The results of the descriptive and inferential data analysis, conducted using one-way MANOVA, indicate that the psychological factors of identity, interest, the self-concept, and self-efficacy for women are significantly higher than those for men. Furthermore, the Pearson analysis demonstrated a significantly strong positive correlation between the psychological factors tested

Keyword: Women Emancipation, Psychological desire

Introductioan

A report distributed by the American Association of University Women (AAUW) found that increasing women's efforts, interest, and participation in STEM education can accelerate success in innovation and competitiveness (AAUW, 2010). The report suggests the importance of fostering balanced engagement between genders, highlighting the mutual dependence between STEM and women including physics education (Lee & Song, 2018). But in reality according to the (UNESCO UIS, 2018) women represent only 30 percent of the population of physicists. (Gitnux Marketdata Report, 2024) shows Women earned only 21% of Physics Bachelor's degrees in the US in 2019.

However, different data was obtained in Indonesia, a survey for top 20 universities conducted by (Kuswanto, 2009) showed that 64% of female students compared to 36% of male students took physics education as their major. This is supported by newer report on demographic analysis from research by (Barnas & Ridwan, 2019; Kuswanto, 2009) which shows that the number of women is greater than men. This interesting fact shows that Indonesia really provides a lot of space for women to make their choices in fields that tend to be filled by men. This shows the possibility that Indonesian women have a fairly high desire to major in Physics Education.

In determining the major to be taken during college, pre-university students usually have their own

Email: hisbulloham@gmail.com

considerations and are influenced by various underlying factors, which can be internal and external factors. In addition to factors related to work, identity, self-esteem, education, self-efficacy, society, culture and environment, researchers have discovered a number of key variables that are indirect or contextual, and that have an undoubted or destructive impact on women. For example, individual feedback and contextual adaptability can influence students' engagement, experiences, and attitudes toward STEM subject (Ertl et al., 2017a). (Vondracek & Porfeli, 2008) shared that individual feedback and contextual adaptability of caregiving relate to the available belongings that individuals observe to be supported in the environment in which they find themselves as well as the culture and cultural ideas in which the individual is rooted. It is also correlated with socio-economic ranking and social acquaintance as a signal of a reciprocal relationship with individual feedback.

In fact, one's own factors may be an important factor in why enlightened Indonesian women have the intention to be in this field. Based on the theory of Planned Behavior (TPB) by (Ajzen, 1991) explains that intentions are a strong predictor of human behavior and the underlying cognitive processes where personal standards, attitudes, and observed behavioral control can predict intentions. On the other hand, (Lent & Brown, 2019) Social Cognitive Career Theory (SCCT), states that an individual's decision to choose a particular professional path is the final result of a combination of various cognitive and environmental factors as well as immediate actions and behavior. TPB and SCCT have played an important role in interpreting early cognitive selection of professions and human behavior. These two theories are revealed to be Based on this theory, psychological aspects can be derived and can be a good psychological predictor for predicting female students' intentions to choose the field of physics education. Thus, the aim of this research is to determine the magnitude of psychological factors in the aspects of identity, interests, the self-concept and self-efficacy, as well as to determine the differences in psychological aspects in the aspects of identity, interests and self-efficacy. the self-concept and self-efficacy based on interests as well as to examine the relationship between variables in psychological aspects.

Literature Review
Indonesian woman empower on physics education
STEM areas are sometimes perceived as fields that are closely associated with men. Jans in (F.J. Monks, 2019) posits that from the beginning, there are differences in the two sexes in what might be called the initial conditioning matrix. With regard to this, it may be considered that there is a biological basis that allows the two sexes to develop different behaviours. In addition, gender stereotypes and biases play an important role in shaping perceptions of STEM fields including physics and the opportunities available to women. These biases can decrease the likelihood of women enrolling in STEM programmes at university and pursuing careers in STEM fields (Makarova et al., 2019). However, a report from the American Association of University Women (AAUW) found that increasing women's effort, interest, and participation in STEM education can accelerate success in innovation and competitiveness of an institution. Yet worldwide, we see that women do not hold a large share in this field. Conversely, Indonesia has historically experienced a phase of enlightenment in terms of emancipation in the field of education. This can be attributed to the historical figure Raden Ajeng Kartini, who revolutionised the freedom of education for women during colonialization. This revolution is reflected in the current situation, where the developing the field of physics in the context of education is played more by women (Kuswanto, 2015).

A study conducted by (Barnas & Ridwan, 2019) at universities in Indonesia revealed that the proportion of female students in physics education majors is greater than that of male students. A comparative causal analysis conducted concurrently with the aforementioned study revealed that female students in physics education exhibited superior knowledge, attitudes, and behaviors in all three domains. Research conducted by (Tai & Sadler, 2001) indicates that women are capable of competing with men in the context of physics problem-solving at the university level. This finding is of significant importance in demonstrating that women are afforded the same opportunities as their male counterparts. It is evident that Indonesian women face a number of challenges in this field.

A multitude of factors influence an individual's choice of major and field of study, as well as their identity, self-esteem, and self-efficacy. Societal and cultural influences, as well as environmental factors, can also play a role (Brenøe & Zölitz, 2020; Guo et al., 2019). Nevertheless, it is crucial to examine the psychological factors in isolation in order to gain a deeper understanding of the fact that Indonesian women have a strong intention to be empowered and enlightened in the context of education in this field.

Theory of planned behaviour
The Theory of Planned Behavior (TPB), developed by (Ajzen, 1991), is a widely used framework in understanding human behavior. It posits that an individual's intention to perform a behavior is influenced by three key factors: attitudes, subjective norms, and perceived behavioral control. This theory

has been extensively applied in various fields, including health-related behaviors, consumer behavior, and educational settings(Bosnjak et al., 2020).In the context of students choosing science-related such like physics education majors in university, the TPB can be applied to understand the factors that influence their decisions.

Attitudes towards science and science-related fields play a crucial role in determining students' intentions to pursue these majors. A positive attitude towards science can be influenced by various factors such as the perceived relevance and importance of science in real-life applications, the perceived enjoyment and challenge of studying science, and the perceived social norms and expectations around pursuing science-related fields. Research has shown that students who have a positive attitude towards science are more likely to choose science-related majors (Kiriakidis, 2017)

Subjective norms refer to the perceived social pressure and expectations from others that influence an individual's behavior. In the context of choosing science-related majors, subjective norms can be influenced by factors such as parental expectations, peer influence, and societal expectations around pursuing science-related fields. Research has shown that students who perceive that their peers and family members value and pursue science-related fields are more likely to choose these majors (Sutton, 1998).

Perceived behavioral control refers to the perceived ease or difficulty of performing a behavior. In the context of choosing science-related majors, perceived behavioral control can be influenced by factors such as the perceived difficulty of the coursework, the availability of resources and support, and the perceived relevance and applicability of science to real-life situations. Research has shown that students who perceive that they have the necessary skills, knowledge, and resources to succeed in science-related fields are more likely to choose these majors (Ajzen, 1985)

The TPB can be applied to understand why students choose science-related majors. Students who have a positive attitude towards science, perceive that their peers and family members value and pursue science-related fields, and perceive that they have the necessary skills, knowledge, and resources to succeed in these fields are more likely to choose science-related majors. Conversely, students who have a negative attitude towards science, perceive that their peers and family members do not value and pursue science-related fields, and perceive that they lack the necessary skills, knowledge, and resources to succeed in these fields are less likely to choose science-related majors

Social Cognitive Career Theory (SCCT)

Social Cognitive Career Theory (SCCT), developed by (Lent & Brown, 2019) is a comprehensive framework for understanding the complex processes involved in career development. It integrates various elements from earlier career theories, such as Holland's theory of vocational personalities and Krumboltz's theory of career development, to provide a more nuanced and dynamic understanding of how individuals develop their vocational interests, make occupational choices, and achieve career success.

Key Components of SCCT

The theory is centered around three core components: (1) interest, (2) choice, and (3) performance. These components are interconnected and influence each other throughout the career development process.

1. Interest: SCCT posits that people's interests are shaped by their experiences, self-efficacy, and outcome expectations. These factors influence the development of vocational interests, which are critical in determining career choices.

2. Choice: The theory emphasizes that career choices are influenced by a combination of personal factors (e.g., interests, abilities, values), social factors (e.g., socioeconomic status, gender, race), and economic factors (e.g., employment opportunities, training opportunities). SCCT highlights the importance of considering these factors in understanding career choices.

3. Performance: SCCT views career performance as a dynamic process influenced by factors such as self-efficacy, outcome expectations, and learning experiences. The theory suggests that individuals' career performance is shaped by their ability to adapt to changing circumstances and to continuously develop their skills and knowledge

Theoretical Frameworks

Framework of this present study is grounded on two theories namely the Theory of Planned Behaviour (TPB) (Ajzen, 1991) and Social Cognitive Career Theory (SCCT) (Lent & Brown, 2019). (Bosnjak et al., 2020) explain that the Theory of Planned Behaviour (TPB) theorises that intention is the solid predictor of human behaviour and the underlying cognitive processes where personal standards, attitude, and observed behavioural control predict the intention. Actual examples of human behaviour include aspects of norms, goals, attitude and the sense of control over their actions, are all interrelated (Ajzen, 1991). The Theory of Planned Behaviour has predictive ability for physics education selections. The Social Cognitive Career Theory (SCCT) is an important theoretical

foundation for this research (Lent & Brown, 2019) and this theory posits that an individual's decision to select a specific profession route is the final result of the combination among numerous cognitive and environmental factors together with immediate actions and behaviours (Brown & Lent, 2019). TPB and SCCT have played an important role in interpreting premediated cognitive selection of profession and human behaviour, correspondingly.

Hypothesis

H$_1$: There is no significant relationship between psychological aspect based on female and male student identity, interest, the self-concept, and self-efficacy.

H$_2$: There is no significant relationship among variables in psychological aspect

Methology

Research Design

This research uses a quantitative approach with a survey method. We involved 100 samples taken from a population of 140 consisting of 77 female and 23 male physics education students in one of the regions in Indonesia using random sampling following the statistics of (Krejcie & Morgan, 1970). The researchers adapted the survey questions to align with the current research context where they were deemed important. Table 1 shows the variables, basis for using the instrument, number of items, and examples of sample items taken from the questionnaire.

Table 1.   Adapted scales for all the aspects

Variable	Source	No. of Items	Example
Identity	(Singer et al., 2020)	18	"I frequently encounter high-achieving STEM professionals who have achieved significant success."
Interest	(Kier et al., 2014)	9	"I will study more for STEM-related lessons."
Self-Concept	(Betz et al., 2021)	25	"I learn better in STEM-related subjects compared to other subjects"
Self-Efficacy	(Kier et al., 2014)	7	"How confident are you that you can get good grades in your STEM courses this semester?"

Data analysis

Data analysis used in the context of this research involves descriptive analysis and inferential analysis.

Descriptive statistics were used to quantify the characteristics of the data and highlight numerical features, which are deemed the most important (Antonius, 2003). Interpretation of descriptive data follows the categories in table 2. Inferential statistics were used to make inferences about the population based on the sample data. According to Antonius (2003), inferential statistics can be used to generate predictions of the population and make generalization from the sample. Inferential statistics in this research involve one-way MANOVA to explain the relationship between variables and Pearson correlation to explain the correlation between variables.

Table 2. Mean interpretation of descriptive analysis on each Psychological aspects

Mean Score	Interpretation
0.00 – 2.00	Low
2.01 – 3.00	Low Moderate
3.01 – 4.00	High Moderate
4.01 – 5.00	High

Finding and Discussions

Finding

Level of each Psychological aspect

Based on the first research objective to determine the level of psychological aspect in aspects of identity, interests, the self-concept, and self-efficacy. The psychological aspect has four aspects, namely identity, interests, the self-concept, and self-efficacy. Table 3 shows a detailed descriptive analysis, including frequency values, percentages, means, standard deviations, and interpretations for each of these important aspects. The mean value results for each aspect and gender are interpreted in accordance with the data interpretations in Table 2. The data indicates that, in terms of psychological impulses in each aspect, female students achieve higher scores than male students. This result can be seen in detail. With regard to the identity aspect, female students achieved a score of 3.673, which can be classified as high moderate, while men achieved a lower score of 3.136, which can also be classified as high moderate. Similarly, women achieved a score of 3,669 in the aspect of interest, while men scored lower at 3,136. The final two aspects, namely the self-concept and self-efficacy, demonstrate that female students achieve a high moderate level, while male students achieve a low moderate level.

Table 3. Descriptive analysis

Gender	Psychological Aspect	Shaphiro-Wilk Analysis	Mean	Mean (5 scale)	Interpretation
Female	Identity	0.070	62.452	3,673	High Moderate
	Interest	0.413	25.685	3,669	High Moderate
	Self-Concept	0.057	83.438	3,476	High Moderate
	Self-Efficacy	0.520	23.986	3,426	High Moderate
Total			195.561	3,651	High Moderate
Male	Identity	0.311	53.318	3,136	High Moderate
	Interest	0.129	21.955	3,136	High Moderate
	Self-Concept	0.117	70.591	2,941	Low Moderate
	Self-Efficacy	0.815	20.136	2,876	Low Moderate
Total			166.000	3.018	High Moderate

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Wilks' Lambda	.910	2.235b	4.000	90.000	.071	
Hotelling's Trace	.099	2.235b	4.000	90.000	.071	
Roy's Largest Root	.099	2.235b	4.000	90.000	.071	

Statistically significant, H_0 is rejected

The results of the one-way MANOVA analysis, with Wilks' lambda, indicate that the value of P = 0.71 is greater than 0.05. This implies that the null hypothesis is rejected and the alternative hypothesis is not rejected. The results indicate that there are significant differences in the mean values of the two genders on each psychological aspect measured. It can be concluded from the above analysis that there is a significantly higher intention among female students to pursue a degree in physics education than male students.

The Psychological Aspect Based on Gender

In order to demonstrate the existence of differences in psychological factor aspects between the sexes, a comparison of psychological aspects based on gender was conducted using a one-way MANOVA. Before conducting the MANOVA analysis, the researchers ensured and confirmed that the data were normally distributed and homogenous. To verify the normal distribution of the data we conduct shaphiro-wilk analysis on the data as seen on table 3 and homogeneity of the data analysed using box M test where is $P = 0.892 > 0.001$ which states that the data is homogeneous. In additions mahalanobis distance is perform to measure there is no univariate and multivariate outliers on the data. Mahalanobis distance analysis shows that the $P > 0.001$. The last prerequisite is that we expect the absence of a multicollinearity problem so pearson correlations analysis is carried out by expecting the value to be less than 0.9. based on pearson correlation analysis obtained the correlation value is $r < 0.9$.

The Relationship of Each Psychological Aspect

To identify the relationship between variables in psychological aspect, the researchers conducted Pearson Correlation analysis. This analysis is carried out to determine whether each aspect has a strong relationship with each other which concretely indicates whether the intention to choose a physics education major can only be determined by only one aspect or must require all four aspects. Because correlation measures how related each aspect. Table 5 and figure 1 shows the results of the Pearson Correlation analysis.

Table 4. One Way Manova Analysis

Effect		Value	F	Hypothesis df	Error df	Sig.
Gender	Pillai's Trace	.090	2.235b	4.000	90.000	.07

Table 5. Pearson Correlation analysis

Variable		Identity	Interest	Self_Concept	Self_Efficacy
1. Identity	Pearson's r	—			
	p-value	—			
2. Interest	Pearson's r	0.882**	—		
	p-value	< .001	—		
3. Self_Concept	Pearson's r	0.854**	0.870**	—	
	p-value	< .001	< .001	—	

Variable		Identity	Interest	Self_Concept	Self_Efficacy
4. Self_Efficacy	Pearson's r	0.810**	0.767**	0.815***	—
	p-value	< .001	< .001	< .001	—

Note. All tests one-tailed, for positive correlation.

* p < .05, ** p < .01, *** p < .001, one-tailed

(a)

(b)

Figure 1. correlation between each psychological aspects on (a) female; (b)Male.

Based on Table , there is a significant relationship between identity and interests ($r = 0.882, p < 0.001$),

the self-concept ($r = 0.854, p < 0.000$), and self-efficacy ($r = 0.810, p < 0.001$). Furthermore, a significant relationship was found between interests and the self-concept ($r = 0.870, p < 0.000$) and self-efficacy ($r = 0.767, p < 0.000$). Additionally, there is a relationship between the self-concept and self-efficacy ($r = 0.815, p < 0.000$). This shows that there is a positive correlation ($0 > r > 1$) between each aspect and each other and that there is a positive correlation between each aspect. the strength of the relationships is very strong.

Discussions

The question of whether women are incompetent in the world of science and technology may have an impact on women's psychological well-being (Carli et al., 2016). This is due to the long history of world civilisation, which has traditionally placed women in a subordinate position. However, changes in civilisation, culture and mainstream ideology after the fall of the Berlin Wall, including the emergence of feminism and liberalism, have led to the idea that opportunities are equal for all humans (Schreiber, 2014). Nevertheless, gender bias against women remains deeply entrenched, even among those who are aware of the opportunities available to them to participate in various aspects, including science (Ertl et al., 2017b). From a biological perspective, Jans (F.J. Monks, 2019) posits that from the outset, there are inherent differences between the two sexes in what is referred to as the initial conditioning matrix. In this context, it can be posited that there is a biological basis that allows the two sexes to develop different behaviours. Additionally, gender stereotypes and biases also play an important role in shaping perceptions about science/STEM fields, including physics and the opportunities available to women (Carli et al., 2016; McKinnon & O'Connell, 2020). This description is based on various reasons, but the findings of the American Association of University Women (AAUW) state that increasing the efforts, interest and participation of women in STEM education can accelerate the success of innovation and the competitiveness of an institution. However, globally, women do not have a significant presence in this field. Various stereotypes aimed at women may eliminate the desire to participate in this field psychologically. Indonesia, which recently underwent an emancipation revolution following the efforts of Raden Ajeng Kartini, has demonstrated a notable interest in science education, particularly in the field of physics (Kuswanto, 2015).

This research confirms that the large number of female students in Indonesia who study physics education is based on the existence of psychological
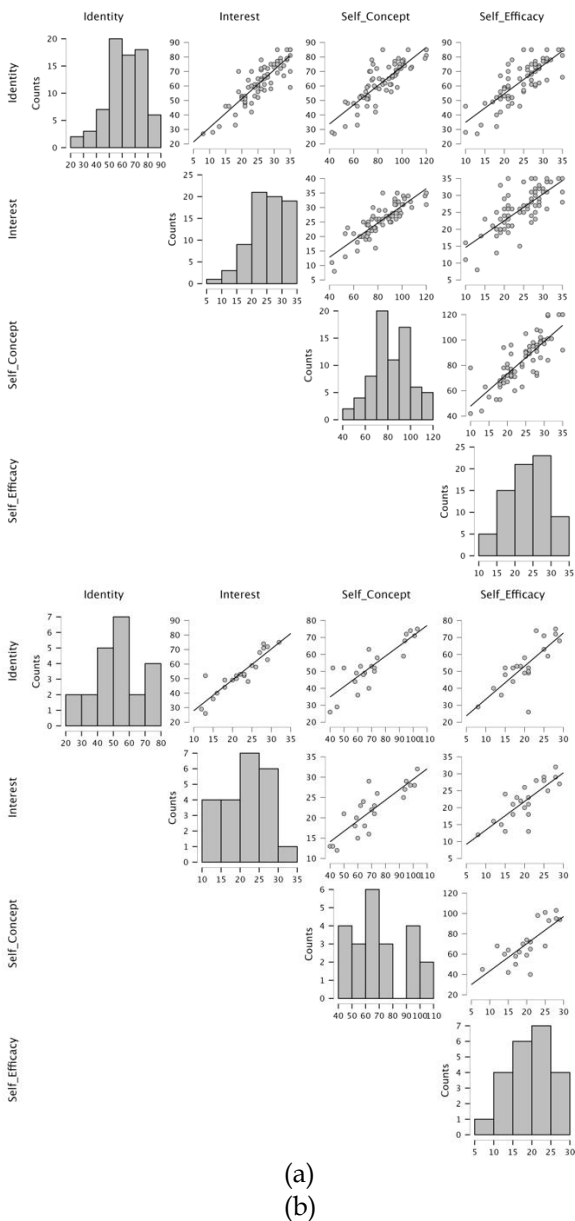
encouragement that challenges gender barriers and stereotypes of women and science/physics itself. Based on descriptive analysis from the psychological aspects survey to determine the level of desire of each student to pursue physics education as a major, it shows that female students apparently have stronger psychological drives than men. Table 3 reveals that women exhibit a higher level of identity (M = 3.673) than men (M = 3.136). Similarly, women demonstrate a higher level of interest (M = 3.669) than men (M = 3.136). In the domain of self-concept, women exhibited a higher level, with a score of 3,476, categorised as high intermediate, in comparison to a score of 2,941 for men, categorised as low intermediate. Furthermore, in the domain of self-efficacy, women exhibited a higher level, with a score of 3.426, in comparison to a score of 2.876 for men. The results of the one-way MANOVA inference analysis in Table 4, which measures the degree of significance of the differences between the two gender groups, indicate that there is a significant difference between the two genders in their psychological aspects. The obtained significance value, which is greater than 0.05, namely $P=0.071>0.05$, indicates that there is a numerically significant disparity in the mean scores of both genders with regard to each psychological aspect. A previous study by Hall & Butler, (2022) explored the influence of identity on the success of women in science. The findings of this study confirmed that identity determines the success or failure of a person, especially women, in science. Barton et al., (2013) previously stated that "identity is a powerful aspect for understanding student learning because identities are aspected through practice—practice that requires knowledge, skills, and ways of thinking that characterize the discipline in which one is engaging". In a study of the relationship between gender, interest and science (Kang et al., 2019), he found a positive correlation between personal innovation and the interests of women. Ertl et al., (2017b) posited that this psychological aspect is shaped by experience and the interpretation of the environment, influencing a person's feelings of self-confidence, competence, and ability. In his findings, he posited that this is closely related to a person's achievement. Moreover, self-efficacy, as defined by Robinson et al., (2022), can be a predictor of an individual's success in science learning. A significant disparity exists between the psychological factors of women and men in the context of higher education in Indonesia. This phenomenon may be indicative of a broader reflection of empowerment within the Indonesian university context.

The observed difference in mean values, as determined by psychological aspects, indicates that women's scores as a whole are significantly higher than those of men. This was subsequently confirmed by demonstrating a link between the aspects that form a psychological factor. A correlation test with Pearson correlation was carried out, which showed a very strong positive correlation and consistent, as evidenced by Table 5 and Figure 1. This is an intriguing finding, as it suggests that the grounding theory process of TPB and SCCT can be conceptualised as four interrelated psychological aspects. This implies that a high or low, Incrases and decrases score on one aspect can influence the scores of the other aspects. For instance, if the identity aspect is high, the scores of aspects such as interest, self-concept and self-efficacy will also be high. This demonstrates that in predicting psychological factors, there is a general psychological factor that influences the intention to major in science, particularly physics at university. Ajzen, (1985) himself stated that his theory, namely the theory of planned behaviour, can predict a person's behaviour with high accuracy. Similarly, the cognitive-empirical theory, which has been supported by decades of research, suggests that competence beliefs, such as self-efficacy beliefs, are important antecedents of achievement-related outcomes (Bandura, 1977; Lent & Brown, 2019). Therefore, the four factors that form this psychological aspect are appropriate predictors of students' intentions to major in science, with a particular focus on physics.

Conclussions

The gender bias that places women as incapable people ultimately reduces their psychological drive to engage with the field of science, especially physics, which is in stark contrast to the prevailing attitudes at universities in Indonesia. This research has demonstrated that, when psychological constructs including identity, interest, the self-concept, and self-efficacy are considered, women are significantly higher than men based on descriptive and one way MANOVA analysis. The four psychological factors, including identity, interest, the self-concept, and self-efficacy, were tested as potential predictors of an individual's intention to pursue a career in science, particularly physics. The findings of the correlation analysis indicated that each construct exhibited a strong relationship with the others. This was based on Pearson correlation analysis, which produced a significantly strong positive correlation. Therefore, if one of the constructions is high or low, it will also determine the height of the other constructions.

Future recommendations
The findings of this research indicate that all constructs are interrelated based on correlation analysis. The

findings indicate the presence of psychological factors in the construct format of Identity, Interest, The Self-Concept, and Self-Efficacy, which are derived from the two TPB and SCCT theories. These factors are observed to predict psychological intentions in choosing a major or job. This provides an opportunity for further testing on a larger sample to ascertain the consistency of the findings.

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