STEM Interest, engineering-oriented career identity, and academic self-efficacy on engineering study intention: A SEM analysis among senior high school students

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Abstract
Recognizing the critical contribution of the engineering field to national human resource development and innovation, coupled with the existing challenge of low student interest in engineering careers among Indonesian high school students, this study aims to analyze the influence of STEM Interest and Academic Self-Efficacy (ASE) on Engineering Study Intention (ESI) through the mediating role of Engineering-Oriented Career Identity (EOCI). Using a quantitative survey approach, data were collected from 695 students participating in the university entrance selection process. Instruments were adapted from prior validated studies and measured on a 1–6 Likert scale. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS 3. Based on the processed data, the findings reveal that both STEM Interest and ASE significantly foster the development of EOCI among students ($\beta = 0.420$ and $\beta = 0.425$, $p < 0.001$). In turn, EOCI strongly predicts ESI ($\beta = 0.654$; $p < 0.001$). However, the direct effects of STEM Interest and ASE on ESI were non-significant, confirming that EOCI fully mediates the relationship. This indicates that students' motivation and confidence affect their intention to pursue engineering primarily through identity development. The model explains 45.1% of the variance in EOCI and 43.6% in ESI, with satisfactory convergent and discriminant validity and good model fit (SRMR = 0.039, NFI = 0.948). These findings affirm the importance of forming an engineering career identity in supporting students' transition to engineering education. Practical implications include strengthening motivational programs and engineering career exploration from secondary education.

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1. Introduction

Increasing the interest and participation of the younger generation in the fields of Science, Technology, Engineering, and Mathematics (STEM) is a strategic issue in developing superior human resources in the 21st century. STEM not only reflects the field of study, but also the foundation of technological innovation and the nation's competitiveness (Bybee, 2013). In Indonesia, despite various national policies, such as the Merdeka Curriculum, integrating STEM approaches, recent research indicates that students' interest in STEM careers, particularly in engineering, remains low and uneven (Solihah et al., 2024; Nugraha et al., 2023). Strong STEM interest is widely regarded as an early predictor of career preference in science and engineering (Kurniati et al., 2022). However, various studies in Indonesia indicate a significant gap between students' conceptual interests and their actual intentions to choose engineering study programs in higher education (Amalina et al., 2025; Ardwiyanti et al., 2021). This discrepancy highlights a critical area for further investigation to understand the factors influencing students' pathways toward engineering.

Within the framework of Social Cognitive Career Theory (SCCT), an individual's interests and self-efficacy beliefs are fundamental psychological inputs that shape their career paths and intentions (Bandura, 1997). Specifically, strong STEM interest is posited to direct students' attention and engagement towards STEM-related activities, which in turn fosters a deeper identification with these fields and associated careers (Kurniati et al., 2022). Academic Self-Efficacy (ASE), defined as a belief in one's ability to succeed in challenging academic tasks, is crucial in shaping students' confidence in solving complex academic challenges in engineering. It empowers students to envision themselves overcoming the complexities inherent in demanding fields, such as engineering, thereby contributing to their career identity development (Bandura, 1997). In the SCCT model, ASE is also viewed as mediating the relationship between learning experiences and career intentions.

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A critical psychological construct in this context is Engineering-Oriented Career Identity (EOCI), which represents a student's self-perception as a future engineer. This identity is shaped by learning experiences, exposure to engineering fields, and social perceptions, and it is a strong predictor of students' intentions and persistence in engineering programs (Godwin, 2016). EOCI can mediate the influence of cognitive and affective variables on career behavior, acting as a bridge between abstract interests and concrete career choices (Patrick & Borrego, 2016). Longitudinal studies in various countries have shown that EOCI is positively correlated with the intention to continue engineering studies and persistence in college engineering programs (Verdín & Godwin, 2018). While the general importance of STEM interest and academic self-efficacy is well-established, the precise pathways through which they translate into a concrete intention to study engineering, particularly the mediating role of a specific career identity like EOCI, require more nuanced empirical investigation.

Despite the conceptual foundation, there is still a lack of empirical studies that systematically investigate how STEM interest and ASE function as direct or indirect predictors of students' intention to pursue engineering studies. More importantly, limited research has incorporated engineering-oriented career identity (EOCI) as a mediating psychosocial construct. While some international studies (Godwin, 2016; Patrick & Borrego, 2016) have demonstrated EOCI as a bridge between cognitive-affective variables and engineering career intentions, this construct remains underexplored in the Indonesian context, particularly among senior high school students preparing for university entrance.

This study addresses this gap by modeling the influence of STEM interest and ASE on engineering study intention (ESI) through the mediating role of EOCI. The novelty of this research lies in two key contributions:

a. it simultaneously examines the interplay among STEM, ASE, EOCI, and ESI within the SCCT framework using PLS-SEM analysis on empirical data from 695 Indonesian high school students, and

b. it extends the empirical understanding of how career identity serves as a psychological mechanism that links student motivation to educational decision-making, especially in developing country settings.

Thus, this research not only offers a theory-driven quantitative analysis but also provides a conceptual foundation and practical implications for designing educational interventions and engineering career development programs beginning at the secondary school level.

1.1. Literature Review

1.1.1. Interest in STEM

Interest in STEM (Science, Technology, Engineering, and Mathematics) is a form of individual interest that arises in activities and careers related to science and technology. This interest reflects students' intrinsic affection, values, and interest in learning and exploring science and engineering (Bybee, 2013). A study conducted by Solihah et al. (2024) shows that a curriculum that explicitly integrates STEM learning is able to increase students' curiosity and interest in science and technology in Indonesia. However, other systematic research reveals that high interest in STEM has not always been accompanied by career intentions in engineering, particularly in the high school student population in Southeast Asia (Kurniati et al., 2022; Amalina et al., 2025).

Intervention programs such as CIS-STEM (Career Interest Survey-STEM) developed by Tyler-Wood et al. (2010) have been widely used to map STEM interests and their relevance to students' career choices. STEM interests are considered one of the early predictors of course choice and students' intentions to enter technology- and engineering-based careers.

1.1.2. Academic Self-Efficacy (ASE)

Academic self-efficacy (ASE) refers to students' confidence in their ability to complete challenging academic tasks. This theory has its roots in the concept of self-efficacy in Social Cognitive Theory (Bandura, 1997) and has been shown to be one of the important predictors of academic achievement and career choice in science and engineering (Sawitri & Creed, 2021). In the Indonesian context, research by Fatimah et al. (2024) shows that ASE plays a significant role in increasing academic engagement and learning motivation of high school students. ASE is also correlated with perceptions of self-control and expectations of positive outcomes in the career decision-making process. In the SCCT model (Lent et al., 1994), ASE mediates the relationship between learning experience and career intention, making it a central variable in STEM-based career studies.

A study by Sachmpazidi et al. (2025), involving graduate physics students, confirmed that self-efficacy significantly predicted persistence in STEM programs even when controlling for departmental support and academic preparation. These recent findings strengthen the theoretical assumption that ASE is not only

predictive of academic behavior but also a fundamental mediator between academic motivation and career commitment, especially in the STEM context.

1.1.3. Engineering-Oriented Career Identity (EOCI)

Engineering-oriented career identity (EOCI) is a self-representation formed from students' perceptions of themselves as aspiring engineers. Godwin (2016) defines EOCI as a combination of social recognition, performance-perception of competence, and a sense of belonging to the engineering community. This identity is formed gradually through learning experiences, social modeling, and exposure to the world of engineering. Several studies show that EOCI is a strong predictor of students' intention and persistence in engineering programs (Godwin 2016). This identity also bridges the influence of cognitive and affective variables, such as self-efficacy and interest, on career behavior (Patrick & Borrego, 2016). In Indonesia, research on EOCI remains limited, despite its relevance to the context of vocational education and programs aimed at strengthening the Pancasila student profile.

Recent studies strengthen the relevance of EOCI as a predictor of career intention. For instance, Rabinowitz (2025) found that students who participated in a machine learning-integrated STEM curriculum reported stronger engineering identities and a greater likelihood of pursuing engineering studies. Similarly, Pregowska (2025) showed that EOCI, rather than interest alone, predicted students' long-term commitment to engineering careers, particularly after immersive science engagement experiences. These findings affirm the importance of strengthening not just interest in engineering, but also the psychological identity and commitment mechanisms that support students' transition into technical and engineering education.

1.1.4. Engineering Study Intention (ESI)

The intention to pursue engineering studies (ESI) reflects students' early commitment to a career in engineering. It serves as a key behavioral proxy in career development models such as SCCT (Lent et al., 2002). However, in the Indonesian context, engineering career intentions remain low due to limited role models, negative perceptions of the profession, and lack of exposure (Amalina et al., 2025). Research suggests that increasing interest in STEM and academic self-efficacy can enhance this intention, particularly when supported by the development of an engineering career identity (Panergayo, 2023).

1.1.5. Relationships between Variables in the SCCT Model

According to Social Cognitive Career Theory (SCCT) developed by Lent, Brown, and Hackett (1994), students' career development is influenced by the dynamic interaction between self-efficacy beliefs, outcome expectations, interests, and contextual factors. Within this framework, academic self-efficacy and interest are not only predictors of educational and career intentions but also key drivers of identity formation, particularly in the STEM domain. Self-efficacy, or the belief in one's academic capabilities, directly shapes students' confidence in navigating future career paths. High levels of self-efficacy have been shown to increase persistence and resilience, which are key psychological factors in strengthening one's identification with a field like engineering (Turner et al., 2019; Halim et al., 2023). When students believe they are capable of succeeding, they are more likely to internalize the identity of a future engineer (Mau, Chen, & Lin, 2021).

STEM interest, defined as affective engagement in learning science and technology, acts as a motivational seed. Although interest alone is insufficient, its combination with strong self-efficacy leads to the development of identity and intention (Luo et al., 2021). This process is cyclical, where self-efficacy and interest reinforce each other through mastery experiences and recognition, which in turn consolidate academic and professional identity (Lent et al., 2008). The formation of an engineering-oriented career identity (EOCI) is understood as a psychological bridge that translates cognitive motivation into behavioral intention. This identity functions as a key mediator connecting initial motivational constructs with career decision-making (Godwin, 2016; Jiang et al., 2024).

The proposed psychological mechanism is as follows: self-efficacy and STEM interest shape confidence and learning engagement. Both then foster the development of a career identity in engineering through the internalization of belonging, competence, and recognition. Ultimately, it is this identity that strongly predicts the intention to pursue engineering studies at the tertiary level. This model is supported by recent empirical evidence (Chan, 2022; Luo et al., 2021) and confirms the central role of identity as a mediating variable, especially for high school students making crucial

2. Method

2.1. Research Design

This study uses a quantitative approach with a correlational survey design to test the relationships between variables in a structural model based on the SCCT developed by Lent, Brown, and Hackett (1994). The

data analysis technique employed was Partial Least Squares Structural Equation Modeling (PLS-SEM), which was chosen because it can accommodate mediation and prediction models with a complex number of indicators and data that are not completely normal (Hair et al., 2021).

2.2. Population and Sample

The population in this study is all grade XII high school students in Indonesia who are participating in the process of preparing for university admission. Samples were selected using purposive sampling techniques, with the following criteria:

a. Grade XII students are active,

b. Taking the Computer-Based Writing Exam (UTBK-SNBT) in 2025,

The total respondents analyzed was 695 students from various provinces in Indonesia, with proportional representation based on gender and type of school (SMA/MA/SMK).

2.3. Research Instrument

This study employed a structured questionnaire to measure four latent variables: STEM Interest, Academic Self-Efficacy (ASE), Engineering-Oriented Career Identity (EOCI), and Engineering Study Intention (ESI). All constructs were measured using Likert-type items rated on a 6-point scale (1 = strongly disagree to 6 = strongly agree). The selection of items and the number of indicators per variable were guided by three key considerations: (1) theoretical relevance based on SCCT, (2) construct operationalization from validated instruments in prior studies, and (3) adaptation feasibility for the Indonesian senior high school context.

2.3.1. STEM Interest (8 items).

STEM Interest was measured using eight items adapted from the Career Interest Questionnaire (CIQ) developed by Tyler-Wood et al. (2010), originally designed to assess interest across science, technology, engineering, and mathematics. The selection of 8 items aimed to reflect balanced representation across the four STEM domains while emphasizing engineering-oriented content. The CIQ has demonstrated good internal consistency in various international studies and has been validated in several Asian educational contexts (Kurniati et al., 2022).

2.3.2. Academic Self-Efficacy (ASE) (5 items).

ASE was assessed with 5 items adapted from Bandura's self-efficacy framework and aligned with education-focused applications of SCCT (Bandura, 2006). Items were selected to reflect students' confidence in completing academic tasks, solving problems, and succeeding in STEM subjects. The decision to include 5 items aligns with studies by Sawitri & Creed (2021) and Fatimah et al. (2024), which found that a concise yet focused ASE scale yields strong construct validity in secondary education populations.

2.3.3. Engineering-Oriented Career Identity (EOCI) (8 items).

EOCI was measured using 8 items based on the multidimensional engineering identity framework developed by Godwin (2016), which includes dimensions of performance/competence beliefs, recognition by others, and interest. To reflect the commitment component, several items were integrated from Patrick & Borrego (2016) on engineering career motivation. The final 8 items were selected after content validation and pilot testing, ensuring both theoretical breadth and contextual clarity for high school students.

2.3.4. Engineering Study Intention (ESI) (5 items)

ESI was measured using five items constructed to assess students' intentionality toward enrolling in engineering majors at the tertiary level. The items reflect goal-setting, commitment, and exploration behavior. The 5-item structure follows recommendations by Lent et al. (2008) on measuring intention in SCCT-based studies and has been applied successfully in recent STEM-related intention research (Jiang et al., 2024; Sachmpazidi et al., 2025).

Each subscale was translated and adapted through a forward-backward translation process, followed by expert review for content validity. Figure 1 shows the SEM model of relationships between variables: STEM Interests, Academic Self-Efficacy, Engineering-Oriented Career Identity, and Engineering Study Intentions.

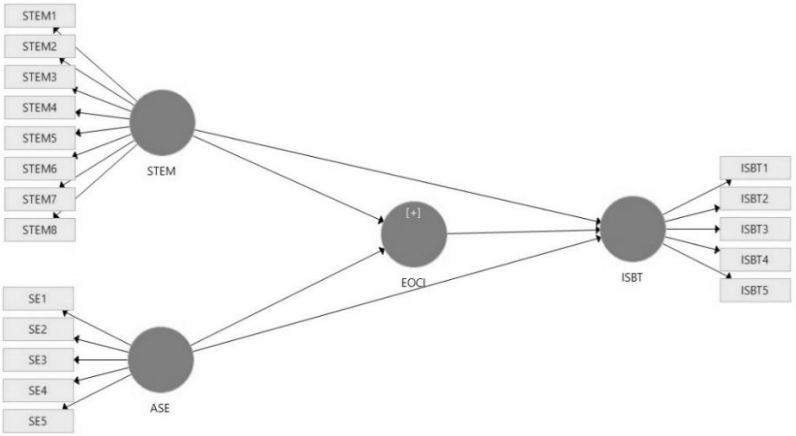

Figure 1. SEM Model: STEM Interests, Academic Self-Efficacy, Engineering-Oriented Career Identity, and Engineering Study Intentions

2.4. Data Analysis Techniques

Data analysis in this study was carried out through several stages, including instrument prerequisite testing, measurement model evaluation (outer model), and structural model testing (inner model), using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach via SmartPLS 3. The analysis procedures are described as follows:

2.4.1. Prerequisite Tests

Before analyzing the structural model, the instruments were tested to ensure validity and reliability. Indicator loadings (>0.70) confirmed item validity, while convergent validity was supported by AVE values above 0.50. Internal consistency was verified through Cronbach's Alpha and Composite Reliability (>0.70). Discriminant validity was established using the Fornell-Larcker criterion and cross-loadings, showing that each construct correlated more strongly with its own indicators than with others.

In addition, multicollinearity was tested using the Variance Inflation Factor (VIF), with all indicators showing values below 5, thus indicating no collinearity issues. Although PLS-SEM does not assume multivariate normality (Hair et al., 2021), univariate normality was examined to support the robustness of the data. Skewness values ranged from –0.293 to –0.053, while kurtosis ranged from –0.851 to –0.440, both well within the acceptable range (±2 for skewness and ±7 for kurtosis), as established by West, Finch, and Curran (1995). These results confirm the appropriateness of the dataset for further analysis using the PLS-SEM approach.

2.4.2. Evaluation of Measurement Models (Outer Model):

a. Convergent validity: outer loading > 0.70, AVE > 0.50

b. Construct reliability: Cronbach's Alpha & Composite Reliability > 0.70

c. Discriminant validity: Fornell-Larcker Criterion, HTMT < 0.90

2.4.3. Evaluation of Structural Models (Inner Model):

a. Test the path coefficient, t-statistical value and p-value

b. R^2 values (evident power of endogenous constructs), f^2 (local predictive effect), and Q^2 (out-of-sample predictive ability)

c. Mediation test using a bootstrapping approach (n = 5000)

2.5. Research Hypothesis

Based on the theoretical framework of SCCT and the conceptual model developed, the hypotheses proposed in this study are as follows:

H1: STEM interests have a positive effect on engineering-oriented career identity (EOCI).

H2: Academic self-efficacy has a positive effect on EOCI.

H3: EOCI has a positive effect on students' intention to continue their engineering studies (ESI).

H4: EOCI mediates the relationship between STEM interests and engineering study intentions.

H5: EOCI mediates the relationship between academic self-efficacy and engineering study intentions.

3. Results and Discussion

3.1. Measurement Model Evaluation Results

Evaluation of the measurement model is carried out as a first step in the Partial Least Squares (PLS-SEM) SEM method, which aims to ensure that the indicators in each construct actually measure the construct in question in a valid and reliable manner (Hair et al., 2021). In this study, there were four main constructs tested: STEM interest, academic self-efficacy (ASE), engineering-oriented career identity (EOCI), and intention to continue engineering studies (ESI).

3.1.1. Convergent Validity

The validity of the convergence was examined through three main indicators: outer loading value, average variance extracted (AVE), and composite reliability (CR). All indicators have an outer loading value above 0.70, with a range of 0.748 to 0.869, indicating that these indicators have a substantial contribution in explaining their respective constructs.

According to Hair (2021), the outer loading value ≥ 0.70 indicates that more than 50% of the variance of the indicator is explained by its construct. The AVE value for each construct was in the range of 0.589 (STEM) to 0.721 (ESI), exceeding the minimum threshold of 0.50 (Fornell & Larcker, 1981). This means that each construct manages to explain more than half of the variance of its constituent indicators. The CR and Cronbach's Alpha values also showed very satisfactory results, all of which were above 0.90, indicating a very high level of internal consistency in the construct measurements.

3.1.2. Discriminatory Validity

Discriminant validity measures the extent to which an empirical construct differs from another. This test is carried out through three main approaches:

a. The Fornell-Larcker criterion shows that the AVE root of each construct is higher than the correlation between the other constructs.

b. Cross Loadings prove that each indicator has the highest load on the construct in question, not on the other construct.

c. The Heterotrait-Monotrait Ratio (HTMT) provides a < value of 0.90 across construct pairs, reinforcing the evidence of discriminability between variables.

With the fulfillment of all these criteria, it can be concluded that all constructs in this model meet the requirements of convergent and discriminant validity, as well as are reliable in measuring the hypothetical constructs.

3.2. Structural Model and Hypothesis Test Results

After the measurement model is declared valid and reliable, the next stage is to test the causal relationship between constructs (inner models). This evaluation included path coefficient, statistical significance (t-statistic and p-value), explained power (R^2), effect size (f^2), and predictive relevance (Q^2 and PLS Predict).

3.2.1. Path Coefficients and Hypothesis Tests

Table 1. The results of hypothesis testing and the path relationships between variables

Hypothesis	Path	Path Coefficient	T-Statistic	P-Value	Interpretation
H1	STEM → EOCI	0.420	15.595	0.000	Accepted (Significant)
H2	ASE → EOCI	0.425	15.279	0.000	Accepted (Significant)
H3	EOCI → ESI	0.654	19.113	0.000	Accepted (Significant)
—	STEM → ESI	-0.021	0.588	0.557	Rejected
—	ASE → ESI	0.030	0.870	0.384	Rejected
H4	STEM → EOCI → ESI	0.275	11.631	0.000	Accepted (Full Mediation)
H5	ASE → EOCI → ESI	0.278	11.509	0.000	Accepted (Full Mediation)

Interpretation:

a. The direct pathway from STEM and ASE to EOCI is significant, which suggests that academic interest and efficacy are indeed the foundations of shaping engineering career identity, in accordance with the principles of SCCT (Lent et al., 1994).

b. The EOCI pathway to engineering study intention (ESI) is also very significant, reinforcing the important role of identity in career decisions.

c. The direct pathway from STEM and ASE to ESI is insignificant, indicating that the influence of both on intent must be through the intermediary of EOCI — this is called full mediation.

These findings demonstrate that the identity of engineering careers serves as a psychological fulcrum in the process of transforming motivation (interest and efficacy) into concrete career decisions. Then, the results of the Variable Relationship Analysis Using Smart PLS 3 can be shown in Figure 2.

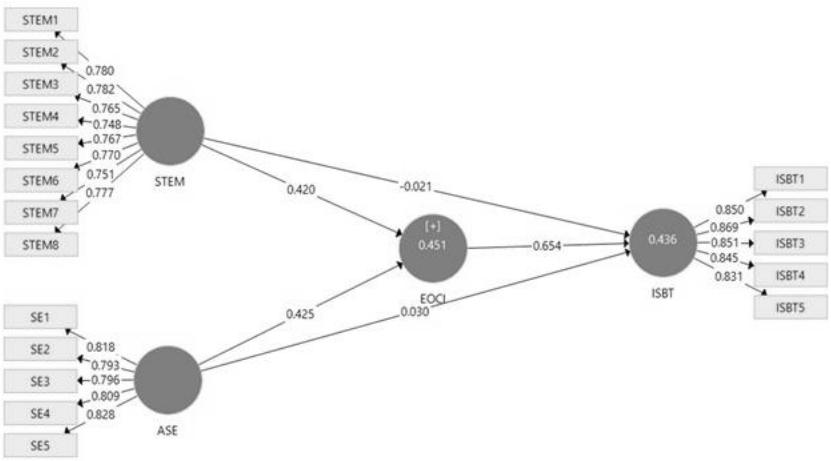

Figure 2. Results of Variable Relationship Analysis Using Smart PLS 3

3.2.2. R^2 value (Coefficient of Determination)

The coefficient of determination (R^2) reflects the proportion of variance in an endogenous construct that is accounted for by its predictor variables. In this study, the R^2 value for EOCI was 0.451, indicating that 45.1% of the variance in EOCI is jointly explained by students' STEM Interest and ASE. Furthermore, the R^2 value for ESI was 0.436, demonstrating that EOCI explains 43.6% of the variance in students' intention to pursue engineering. According to interpretive guidelines by Hair (2021), R^2 values of 0.25, 0.50, and 0.75 are classified as weak, moderate, and substantial, respectively. Thus, the results of this study suggest that both models possess moderate explanatory power, supporting the conclusion that STEM Interest and ASE significantly contribute to the development of an engineering career identity, which in turn plays a central role in shaping students' intentions to pursue engineering studies.

3.2.3. Effect Size (f^2)

The effect size (f^2) was used to assess the local predictive impact of each exogenous variable on its respective endogenous construct, offering insight into the relative strength of each path in the model. The analysis revealed that EOCI had a substantial effect on ESI, with an f^2 value of 0.416, indicating that EOCI is the strongest and most significant predictor of students' intention to pursue engineering.

In contrast, both ASE and STEM Interest exhibited medium effect sizes on EOCI, with f^2 values of approximately 0.30. This suggests that while ASE and STEM Interests significantly contribute to the development of career identity in engineering, their influence on ESI is indirect. The direct effects of ASE and STEM Interest on ESI, however, were found to be negligible ($f^2 < 0.01$), implying that their predictive relevance in the model is only realized through the mediating role of EOCI. These findings reinforce the critical role of career identity as a central pathway connecting students' motivation and self-beliefs to their actual intention to pursue engineering studies.

3.2.4. Predictive Relevance (Q^2 and PLS Predict)

The Q^2 values obtained through blindfolding were 0.294 for EOCI and 0.311 for ESI, both of which exceeded zero, indicating that the model possesses moderate predictive relevance (Shmueli et al., 2019). Results from PLS

Predict further support this, showing that the PLS model outperformed the linear model in terms of RMSE and MAE for predicting EOCI. However, the predictive power for ESI remained relatively weak, suggesting that additional variables such as family influence, school support, or industry exposure may be needed to enhance the model's accuracy in forecasting engineering study intention.

3.3. Discussion

The results of this study provide empirical evidence that supports the theoretical framework of SCCT, particularly regarding the mechanisms that link interest, self-efficacy, identity, and intention within the STEM education context.

First, both STEM Interest and ASE were found to have significant positive effects on EOCI. This suggests that students who enjoy STEM learning and believe in their academic abilities are more likely to perceive themselves as capable and part of the engineering community. These findings align with Godwin (2016), who argued that perceived competence and interest play central roles in forming engineering identity.

Second, EOCI had a significant influence on ESI. Students who internalize an identity as future engineers—feeling recognized, competent, and committed—show stronger intentions to pursue engineering programs in higher education. This supports the idea that identity acts as a mediating mechanism that bridges self-beliefs and career choices (Morelock J. R., 2017).

Interestingly, the direct effects of STEM Interest and ASE on ESI were not significant, suggesting that their influence on intention is fully channeled through identity. This finding emphasizes the centrality of EOCI as a psychosocial driver that converts motivation into academic decision-making (Patrick & Borrego, 2016).

At the component level, the strongest indicators of EOCI were those reflecting students' self-perceived competence and recognition by others, reinforcing the importance of both internal and external validation in forming career identity. Meanwhile, ESI was most influenced by students' future planning and commitment to studying engineering, which are closely tied to their level of identification with the field.

In sum, the model confirms that developing engineering identity is key to transforming STEM motivation into actual career intent. This finding echoes recent research suggesting that identity development should be an explicit goal in STEM interventions (Mau et al., 2021; Rabinowitz, G. et al., 2025).

4. Conclusion

This study demonstrates that engineering-oriented career identity (EOCI) serves as a crucial mediating variable that bridges the influence of STEM Interest and Academic Self-Efficacy (ASE) on students' intention to pursue engineering studies. The PLS-SEM analysis yielded several key findings:

a. Both STEM interest and ASE positively and significantly contribute to the development of engineering career identity;

b. EOCI exerts a strong and direct influence on students' intention to choose an engineering program; and

c. In the absence of EOCI, the direct effects of STEM interest and ASE on study intention become statistically insignificant.

These results provide empirical support for the Social Cognitive Career Theory (SCCT) and highlight the role of identity as a key psychosocial mechanism in students' educational decision-making. The findings enrich our understanding of how motivational factors and self-beliefs are internalized into career identity, which ultimately guides study intention, particularly relevant for the strategic development of Indonesia's human resources in the engineering sector.

The implications of this study suggest that fostering a strong engineering identity among high school students is crucial for converting early motivation into concrete academic choices. Educational initiatives that cultivate both academic confidence and a sense of identification with the engineering profession are more likely to promote student interest in pursuing engineering pathways.

In light of these findings, it is recommended that schools integrate career identity development into STEM learning through mentorship, exposure to real-world engineering contexts, and recognition of student achievements. Curricula should also be designed to build confidence and sustain interest through project-based and interdisciplinary approaches. Furthermore, policymakers and educators should position identity formation as a strategic objective in STEM education, especially for students at the threshold of higher education and career decisions.

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All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

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