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Case report

Motivated and confident: A comparison of undergraduate engineering and non-engineering STEM students in Indonesia

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Abstract: This paper explores the motivations and optimism of undergraduate students enrolled in engineering and non-engineering science, technology, engineering, and mathematics (STEM) programs in Indonesia. Using quantitative analysis of data collected via an online survey distributed through social media platforms, the study finds that engineering students reported higher levels of confidence than non-engineering STEM students, while females more frequently reported career-related motivations. In contrast, non-engineering STEM students exhibited more varied motivational profiles, with male students showing stronger intrinsic value and female students reporting stronger utility and attainment value. Notably, engineering students of both genders expressed strong confidence in their future, while in the case of non-engineering STEM students, female participants reported greater confidence than their male peers, which may reflect an association between external factors and optimism. Understanding the aspirations of students and the factors that affect their confidence is essential for sustaining student engagement and progressing inclusive STEM education strategies that benefit the development of Indonesia.

Keywords: motivation, task value, confidence, expectancy, undergraduate

1. Introduction

As an emerging economy, Indonesia strives to develop industrialization, digital transformation, and global competitiveness. Development policies in Indonesia have emphasized science, technology, engineering, and mathematics (STEM) disciplines as drivers of technological advancement and infrastructure development [1]. Engineering education, in particular, plays a vital role in the cultivation of a technically skilled workforce [2]. Understanding student motivation is essential for building a robust and inclusive STEM workforce [3], motivated not only by career prospects but also by a desire to innovate, discover, and contribute to society [4]. Motivation not only influences academic performance and persistence but also shapes long-term engagement with the profession [5]. By fostering passion, supporting inclusivity, and highlighting the benefit of STEM careers to the community, institutions can not only empower students to pursue STEM but also to persist when they are facing challenges [6].

Motivation in STEM higher education is shaped by students' beliefs about their likelihood of success and the value they attach to their studies. In education, expectancy-value theory has been widely used to explain why students choose STEM programs [7]. This theory explains how people decide whether or not to engage in an activity based on how likely they believe they are to succeed, or the expectancy, and how much they value the task. Eccles' [8] expectancy-value theory added a "situated" component, as it considers the circumstances surrounding students when they make decisions, such as experiences in the past and social context surrounding them including family and community. In this study, we apply expectancy-value theory and examine how these situational factors, including passion, community value, family encouragement, and future career, influence students when choosing their study program. This study also examines students' expectancies for success, reflected in their confidence about their future with the STEM degree they are pursuing.

Within the expectancy-value framework, students' interest in STEM subjects reflects their intrinsic value, while perceptions of future career opportunities represent utility value. Family and community influences contribute to students' attainment value and shape how important they feel it is to succeed, but they also can reduce intrinsic value if students feel forced into a field of study that does not align with their interests [9]. On the other hand, families that encourage exploration and communities that support autonomy can strengthen students' intrinsic value for STEM tasks and reinforce positive expectations of success [10,11]. For instance, parents who engage in science-related conversations, provide access to educational materials, or support participation in extracurricular activities, such as coding camps, can amplify students' interest and passion [12]. In the context of Indonesia, factors like perceived career prospects and influences from family and community shape students' task values, particularly their utility value and attainment value. They are powerful drivers, in addition to passion as an intrinsic value.

The impact of these factors can differ between male and female students and can shape their decisions when choosing their fields of study [13]. Among Indonesian engineering students in particular, academic choices are often tied to expectations of long-term career stability and the desire to contribute to social development, which shapes how they interpret these influences [14]. However, whether they then continue in this field of study is also affected by the challenges that they face and the support they are able to access. Universities' culture and teaching practices also play a role, for example, engineering programs that provide practical applications, allowing students to enjoy a learning process that is more relevant to their daily life, may become more popular than other programs [15]. Universities that promote and support diversity may also reduce attrition rates of women STEM students [16].

STEM careers are generally more appealing to male students than female students in Indonesia [17]. However, when there are family members working in STEM fields, females are more likely to be influenced to pursue STEM studies than males [18]. Nonetheless, even in STEM subjects where female students outperform their male peers, there is a lack of recognition of women's achievements that might detract from long-term engagement [19].

As a developing nation, Indonesia strives to establish a good education system, since empowering students contributes not only to individual success but also to national progress [17]. Students' confidence in their future reflects both how well students believe their education aligns with their long-term aspirations and the likelihood of contributing meaningfully to national technological development and economic growth [20]. In addition, students who feel supported tend to experience lower levels of anxiety and are more likely to persist when facing challenges in their studies [21]. In Indonesia, while the research on STEM education at the primary and secondary level is extensive, it is still limited at the tertiary level [22]. The aim of this research project is to address this gap in the literature on undergraduate STEM students in Indonesia.

Research on Australian engineering students [23] found that what makes students stay motivated and engaged with their study was different for different student types, for example by gender. They also found that different groups thought differently about their future and were more or less confident. Understanding these differences is crucial for designing inclusive education that supports diverse student populations.

By examining the motivations and confidence in the future of engineering and non-engineering STEM students and considering gender differences, this study provides a nuanced understanding of the factors that influence educational choices in Indonesia. These insights can inform policy decisions, curriculum design, and outreach efforts aimed at strengthening inclusive STEM higher education in Indonesia. The research questions addressed in this paper are the following:

(1) What factors shape the motivation of engineering and non-engineering STEM students, and how do these differ by gender?

(2) How do engineering and non-engineering STEM students, across gender groups, differ in their confidence about their future?

2. Methods

An online survey consisting of Likert scale items and open-ended questions was employed, adopting a primarily quantitative approach with qualitative support. The online survey targeted undergraduate students enrolled in engineering and non-engineering STEM programs at higher education institutions in Indonesia. The survey was distributed across all provinces using social media platforms, with data collected via Microsoft Forms.

The survey invitation was posted on a popular engineering education-focused Instagram account in Indonesia, @anakteknikindo (529,000 followers, as of July 2024), a science and technology-focused Instagram account, @warstek (106,000 followers, as of July 2024), and distributed between students via WhatsApp. The survey was distributed from July to November 2024.

For a total population of approximately 635,000 students, based on equation 1, a sample size of 384 was determined to be statistically sufficient. In this equation, z denotes the z-score associated with the selected confidence level (e.g., 1.96 for a 95% confidence level), p represents the estimated proportion of the population exhibiting the characteristic of interest (commonly set at 0.5 when the true proportion is unknown), e refers to the margin of error expressed as a decimal (e.g., 0.05 for a 5% margin of error), and N indicates the total population size [24].

$$n = \frac{z^2 p(1-p)}{e^2 + z^2 p(1-p)/N} \tag{1}$$

We collected responses from 718 online survey participants representing 26 out of 38 provinces in Indonesia. Because recruitment relied on voluntary responses to social-media invitations, the sample represents a nonprobability, self-selected group rather than a statistically representative cross-section of Indonesian STEM undergraduates. Although the final sample size exceeded the minimum requirement, the results should be understood as representing the characteristics of individuals who elected to participate rather than those of the broader undergraduate STEM population in Indonesia.

To explore inclusive strategies that may enhance student engagement, we included demographic questions, including province of origin, gender, age, field of study, and university attended. This paper focuses on fields of study and gender; other demographic factors will be discussed in future work.

The question regarding the field of study, “What study program/degree are you taking?”, offered several predefined options and an open-ended response where respondents could specify an exact program. We received a wide range of responses to the field of study question, from simply “engineering” or “science” to more specific entries, such as mining engineering, industrial engineering, geology, agrotechnology, and soil science. Based on these responses, we categorized 308 participants into the engineering group and 389 into the non-engineering STEM group. Twenty-one students did not disclose any study programs. For the purposes of this paper, we categorized these responses into two groups: engineering and non-engineering STEM, to identify differences between engineering and other STEM students. Engineering was analysed as a separate category because it represented the largest proportion of participants and reflects a particularly prominent enrolment trend in Indonesia.

The non-engineering STEM category included a wide range of disciplines (e.g., pharmacy, psychology, nutrition, science education, and other science-based programs). We acknowledge that these fields differ substantially in terms of career pathways, gender representation, and motivational profiles. However, due to limited sample sizes within individual disciplines, further dis-aggregation was not feasible without compromising statistical power and stability of estimates. Grouping these disciplines therefore enabled a meaningful comparison between engineering and other STEM pathways while maintaining analytic robustness. As such, findings relating to the non-engineering STEM category should be interpreted as representing broad trends rather than discipline-specific patterns.

For the gender question, we used an open-ended format, “How do you describe your gender?”. Among participants who provided a response, 320 were female, 376 were male, and one participant did not disclose a gender. Twenty-one participants did not respond to any demographic information, including gender.

The survey was designed to take approximately 10 minutes to complete, and participants were instructed to submit only one response. It consisted of 14 Likert scale items to generate quantitative data, 4 open-ended questions for qualitative analysis, and 9 demographic questions. Items measuring students’ feelings were adapted from a previously published survey with undergraduate engineering students in Australia [23]. Other questions were reviewed by experts to establish face validity. Given that these items were designed to capture specific constructs grounded in expectancy-value theory, and the aim of this study was to examine responses to individual items rather than to identify latent factors or reduce dimensionality, exploratory factor analysis was not undertaken. Instead, analysis focused on descriptive statistics and comparisons across groups. All questions were presented in Indonesian, with translations by a native speaker. The Likert-scale questions used a six-point scale ranging from "strongly disagree" to "strongly agree", with no neutral midpoint. This paper focuses on responses to 4 out of 14 Likert-scale items and 1 out of 4 open-ended questions related to students' motivation.

Quantitative data from the survey were analysed in Microsoft Excel and in Python (Jupyter Notebook) with the pandas, numpy, and scipy.stats libraries. Frequency distributions for the responses to the Likert scale items were generated using the "COUNTIF" function to show how often each response option appeared. For the descriptive statistic, average responses to the Likert scale items were calculated. Each of the six response options, strongly disagree, disagree, moderately disagree, moderately agree, agree, strongly agree, was converted to a numerical value ranging from 1 to 6, respectively, and averages were then calculated. The use of a six-point Likert scale without a neutral midpoint requires respondents to indicate agreement or disagreement, as reported in the survey design literature [25,26]. Associations between categorical variables were examined using chi-square tests applied to the full response distributions. For each analysis, we report the chi-square statistic, degrees of freedom, p-value, and Cramer's V as an effect size. Mean responses and percentage agreement are presented as descriptive summaries to aid interpretation and are not used for statistical inference. Statistical significance was evaluated using a conventional threshold of $p < 0.05$. Cramer's V values were interpreted using conventional guidelines (approximately 0.10, 0.30, and 0.50 for small, moderate, and large effects), with particular attention to identifying effects of limited practical magnitude. Each chi-square analysis represents a single test of association; however, multiple such tests were conducted across different variables, which increases the overall risk of false-positive findings. We acknowledge this limitation and interpret statistically significant findings with caution.

This paper reports on part of a larger study that uses a mixed-methods approach, using both qualitative and quantitative data from surveys, and also uses interview data from STEM students and academic staff in Indonesia. The survey and interviews ask about students' motivations, confidence, challenges and support. Here, we focus on survey data pertaining to motivation and confidence. The findings on challenges and support are presented elsewhere [21].

3. Results and discussion

3.1 Motivation

3.1.1 Field of study

Figure 1 presents a comparison between the responses of engineering students and those from other STEM disciplines for the two Likert scale statements "I chose this field of study because I am passionate about it" (Figure 1a) and "I chose this field of study because it is valued by my community" (Figure 1b). The response distribution in Figure 1(a) shows that, for both engineering and non-engineering students, agreement with the statement was common. In contrast, Figure 1(b) indicates a tendency toward disagreement. For both respondent groups, descriptively, the overall agreement with the passion-related statement was higher than 90% and with the community-related one was less than 50% (see Table 1). Because the non-engineering STEM group comprises diverse disciplines, the results reported here represent aggregated trends and should not be interpreted as applying uniformly across all individual fields.

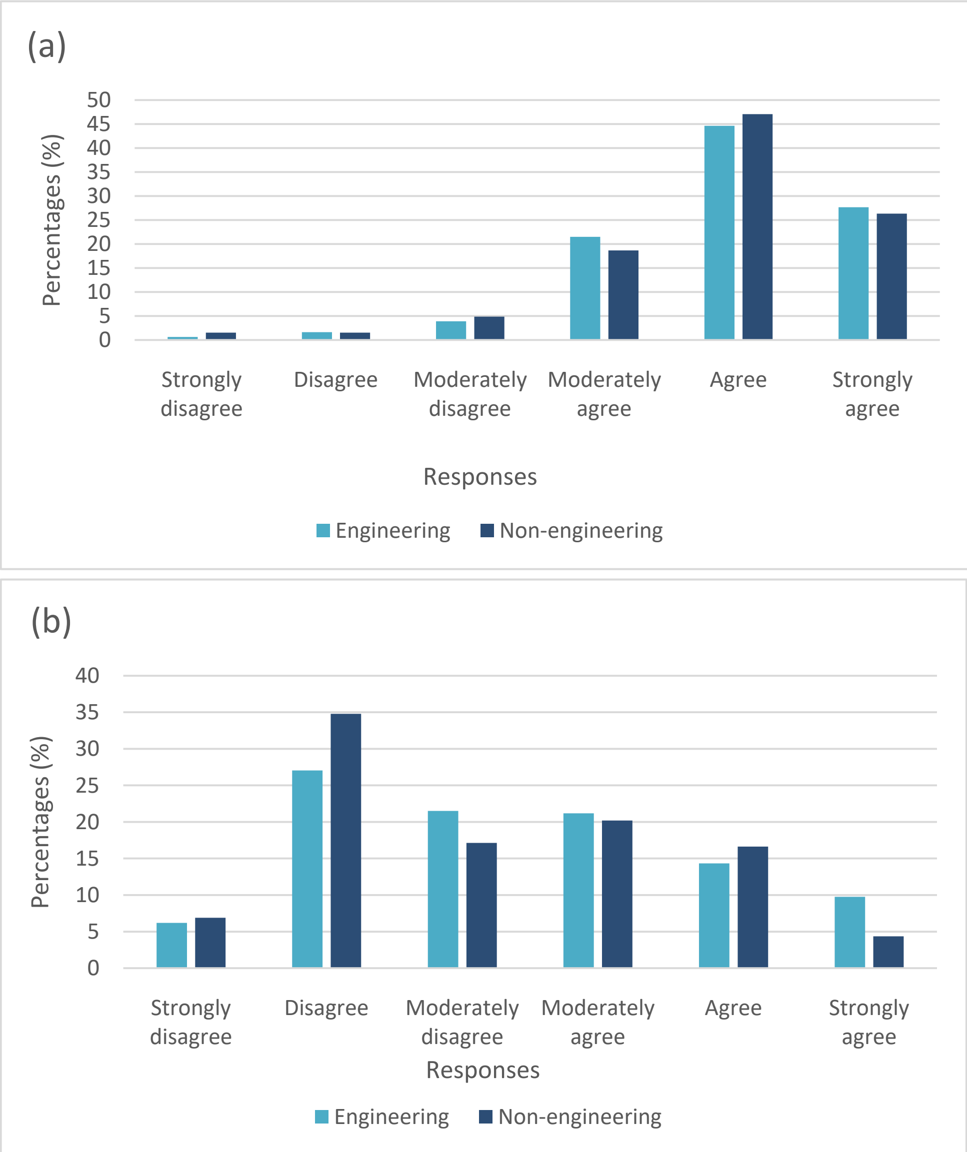

Figure 1. Responses to the statement "I chose this field of study because I am passionate about it" (a) and "I choose this field of study because it is valued by my community" (b) by study program, comparing engineering (308 participants) and non-engineering STEM (389 participants) students.

Further, while there were no differences between the two groups' responses to the passion-related statement, there is a difference in their responses to the community-related statement. A chi-square test of independence indicated a statistically significant association between field of study and response distribution to the community-related statement (see Table 1), however, the effect size was small, indicating that although statistically significant, the difference between groups is modest and of limited practical significance. Engineering students appeared more influenced by community perceptions than students in the aggregated non-engineering STEM group. This may reflect that engineering is often perceived as more prestigious, both in terms of its competitiveness and good career prospects. The community perception of engineering as a challenging and rewarding discipline may contribute to a stronger external influence on students' decisions when choosing their study program [27]. In the case of participants in this study, the influence of community plays a more significant role for engineering students compared to those in other STEM fields.

Table 1 shows the percent agreement and average response, descriptively, to each statement about motivation for choice of STEM discipline. The statements about passion and future career benefits showed very high levels of agreement, with over 90% of participants in both engineering and other STEM groups agreeing. Conversely, when asked about choosing their field of study based on its value to the community, participants tended to "moderately disagree," and fewer than half expressed agreement.

Family encouragement was in-between, with three quarters of respondents agreeing that their family had encouraged them to choose their field of study. From this, it can be inferred that family suggestions regarding the selection of their study program were an important, but probably not primary, factor influencing their decision. Nevertheless, these results indicate that family still plays a role. This is consistent with previous research showing that family support can foster interest and passion for STEM [18].

Table 1. Comparison of motivation for choosing field of study between engineering and non-engineering STEM students.

Statement	"I chose this field of study because I am passionate about it"		"I chose this field of study because it is valued by my community"		"My family encouraged me to choose this field of study"		"I am certain my studies will be beneficial for my future career"	
Cohort	Eng.	Non-Eng. STEM	Eng.	Non-Eng. STEM	Eng.	Non-Eng. STEM	Eng.	Non-Eng. STEM
Average	4.91	4.87	3.40	3.18	4.10	4.07	5.10	4.90
% Agreement	94	92	45	41	75	70	96	93
χ^2(df, n); *p*-value	2.56 (5, 697); 0.78		13.31 (5, 697); 0.02		4.61 (5, 697); 0.47		11.00 (5, 697); 0.05	
Cramer's V [95% CI]	0.06 [0.04, 0.16]		0.14 [0.09, 0.23]		0.08 [0.05, 0.18]		0.12 [0.08, 0.21]	

The level of agreement with the statement "I am certain my studies will be beneficial for my future career" was very high for both groups. This item does not directly measure students' motivations for choosing their field of study, and therefore we cannot infer a causal link between degree choice and career considerations from this response alone. Instead, the result reflects students' confidence that their studies, regardless of how closely their coursework aligns with their intended career, will provide some form of career benefit. Additionally, this result is consistent with existing literature that identifies career motivation as one of main reasons STEM students, including those in engineering, choose their study programs [28].

We also observed that for the statements regarding passion and family encouragement, the *p*-values indicated no statistically significant association was found between field of study and response distribution (see Table 1), indicating that the pattern of responses is similar across groups. This suggests that there is no difference in sentiment between engineering students and those from other STEM disciplines regarding passion and family perspectives on STEM fields, whether the student is in engineering or another STEM discipline.

Differences in perception regarding the importance of community value and future career were observed between engineering students and other STEM students. For community value, a chi-square test of independence indicated a statistically significant association between field of study and response distribution (see Table 1), however, the effect size was small, suggesting that although statistically significant, the difference between groups is modest and of limited practical significance. For future career benefit, the association between field of study and response distribution was marginally significant, and the effect size was again small, indicating that any group differences are weak and of limited practical importance. These may reflect broader differences in community perceptions of the value of engineering compared with other STEM fields. Engineering is often regarded more favorably by communities due to its higher earning potential, wider career opportunities, and more relevant practical applications with social impact [29]. These distinctions could contribute to the observable differences in how these Indonesian students responded to statements concerning community value and future career prospects.

Responses to the open-ended question, "Is there anything else you'd like to tell us about how you feel about your studies, or why you chose the field that you did?", further illustrated that some participants cited passion when selecting their study program. The quotations provided here are direct translations of responses in Indonesian by a native Indonesian speaker and are included as examples of responses to the open question for illustrative purposes.

Participant 178, an informatics engineering student, stated, *"I want to deepen my knowledge in informatics*". Participant 265, an architectural engineering student, shared, "*I'm interested in learning about architecture*". Participant 515, a chemical engineering student, noted, "*Because I liked chemistry in high school*". These responses reflect a strong intrinsic value, suggesting that these students have genuine interest in the subject matter. However, passion is not a fixed trait, it is a dynamic process shaped by experiences [30]. For instance, a student may develop an interest in information technology after attending a coding camp or become fascinated by robotics after receiving a robot toy from their parents. These formative moments of discovery can spark interest and lead to sustained academic engagement. Therefore, educational environments that nurture curiosity and autonomy are essential for cultivating passion [31].

We also observed community-related responses. Participant 36, an engineering student, said "*Indonesia really needs more graduates in STEM fields*". Participant 203, an agrotechnology student, said "*Because I want to return to my village and develop agriculture there*". These responses illustrate that community value is an important driver for some students.

Responses related to family were also observed. Participant 584, an internet engineering Technology student, stated, "*I want to make my parents proud*". Here, we see that parental expectations can serve as a source of strength rather than pressure. Another response from Participant 703, an engineering student, was "*I was inspired by my father*", illustrating how a family member can motivate a student by serving as a role model, fostering interest in engineering through inspiration and example. Participant 177, from informatics engineering, shared: "*Because of full support from my family*". Pursuing an engineering degree often involves significant financial demands to provide laptops, textbooks, and other academic resources [31]. Parental support can play a vital and constructive role in students' academic progress.

Some participants also reported career-related motivations. Participant 648, a chemical engineering student, stated "*There are many job opportunities".* Participant 707, studying informatics engineering, shared a clear personal goal: *"I want to become a programmer*". Another engineering student, Participant 281, noted, "*I want to become a skilled technician*". These findings also align with a previous study that found that Indonesian students in engineering programs often associate their academic choices with long-term career stability and social impact [14].

In summary, the survey data revealed that approximately 90% of the respondents had passion for their chosen field of study. Both engineering and non-engineering STEM students reported receiving similar, high levels of encouragement from their families when selecting their study programs. However, engineering students were more likely to be driven by community values. According to expectancy-value theory, the high levels of encouragement reported by all participants suggest strong expectancy for success and high levels of passion reflect strong intrinsic value. In the case of engineering students, higher attainment value was reflected in the perceived importance of engineering within their social environment [8]. Engineering students were also more certain that their studies would be beneficial to their careers than students in other STEM fields.

3.1.2 Gender

We analyzed whether there were differences in responses between genders regarding their motivation for choosing a study program. Among the engineering program respondents, there were 97 female and 210 male students, while in the non-engineering STEM programs, there were 223 female and 166 male students. One engineering student did not disclose gender and was therefore excluded from this analysis.

We note that the proportion of female students is lower in engineering than in non-engineering STEM fields. According to data from the World Bank [32], the percentage of women enrolled in engineering higher education programs in Indonesia increased from 21.6% in 2015 to 24.9% in 2018. In the broader STEM disciplines, female student participation rose from 36.1% in 2015 to 37.4% in 2018. This upward trend over the three-year period indicates a shift toward greater female representation in STEM fields and reflects ongoing progress in promoting women's involvement in STEM higher education. However, there is still a large gender gap in participation in STEM, and particularly in engineering, in Indonesia.

To address this participation gap, it is important to understand what motivates both male and female students to choose engineering and other STEM fields. Figure 2 shows the responses of male and female engineering and other STEM students to the statement "I chose this field of study because it is valued by my community". "Disagree" was the most common response, with a higher percentage of female engineering students expressing this response compared to their male counterparts, as shown in Figure 2(a). However, results of the chi square test show that the difference in the response distributions was not statistically significant (see Table 2). Figure 2(b) shows the response distribution for STEM students outside of engineering. For these students, "disagree" was also the most common response. However, in contrast to the engineering students, the difference in the distributions was statistically significant and, descriptively, male students showed a higher level of disagreement than female students (see Table 3).

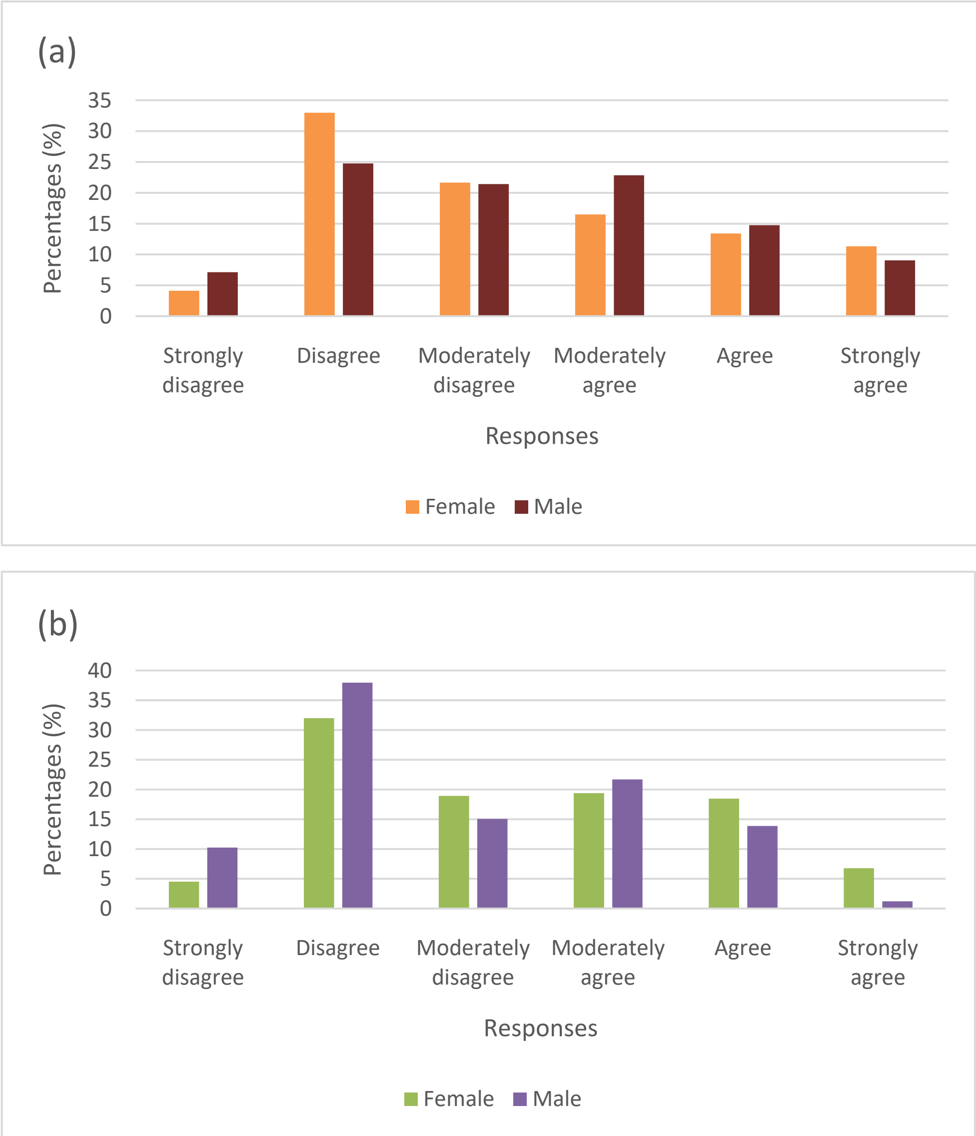

Figure 2. Responses to statement "I chose this field of study because it is valued by my community" by gender of engineering (a) and non-engineering STEM (b) students.

Although the association was not statistically significant, the observed pattern may be understood in light of previous studies indicating that Indonesian society tends to view engineering as a field more suited to men than women [33]. This might be reflected in the higher proportion of female engineering students who reported that community values did not influence their choice of study. On the other hand, male engineering students are more likely to be socially rewarded for choosing engineering, which may explain why nearly half of them expressed agreement with the statement. The opposite trend appears in non-engineering STEM fields. Among the participants, many of the women were in health-related disciplines, particularly nursing and allied health, which society often perceives as more appropriate for women than men [34]. Therefore, it is understandable that a relatively high number of female non-engineering STEM students expressed agreement. Within an expectancy–value theory perspective, social perceptions shape the attainment value students attach to study programs. Unlike engineering, many non-engineering STEM fields, especially health-related disciplines, carry stronger social and attainment value for women, which may be reflected in the responses of the female student participants.

We can also see in Table 2 that among engineering students, both female and male respondents generally agreed with the statement "I chose this field of study because I am passionate about it," with agreement rates exceeding 90% for both groups with no statistically significant association with gender. Among non-engineering STEM students (Table 3), both female and male respondents also tended to agree with the statement, but the percentage of agreement among female students was below 90% while male students showed nearly 100% agreement. A chi-square test indicates a statistically significant difference by gender among non-engineering STEM students for this statement, however, a small effect size indicates a weak association. This suggests that among engineering students, regardless of gender, respondents demonstrated similarly strong passion for their chosen field of study. In non-engineering STEM fields, male students are more likely than their female peers to have chosen their field of study because they are passionate about it. This suggests that their chosen field has notable intrinsic value for them, from the point of view of expectancy-value theory.

Figure 3(a) shows a similar pattern among male and female engineering student respondents to the statement "My family encouraged me to choose this field of study". In contrast, as shown in Figure 3(b), and Table 3, female non-engineering STEM students showed stronger agreement with this statement than their male peers. For all questions we saw significant gender differences among the non-engineering STEM students, but for none of the questions among the engineering students.

However, it is important to recognize that the non-engineering STEM cohort was highly diverse, and the patterns of difference by gender that we observe may correlate with the particular degrees that the participants were enrolled in.

Table 2 shows that, for the statement regarding family encouragement, there is again no statistically significant association between responses and gender for engineering students. Table 3 indicates statistically significant association between gender of non-engineering STEM students and the response distribution, however, the effect size for this item was small to moderate, indicating a modest association. Descriptively, the difference in percent agreement exceeded 10%, with male students showing a lower level of agreement. These findings suggest that both female and male engineering students receive similar levels of family encouragement when selecting their study program. Among non-engineering STEM students, on the other hand, females receive greater family encouragement compared to their male peers.

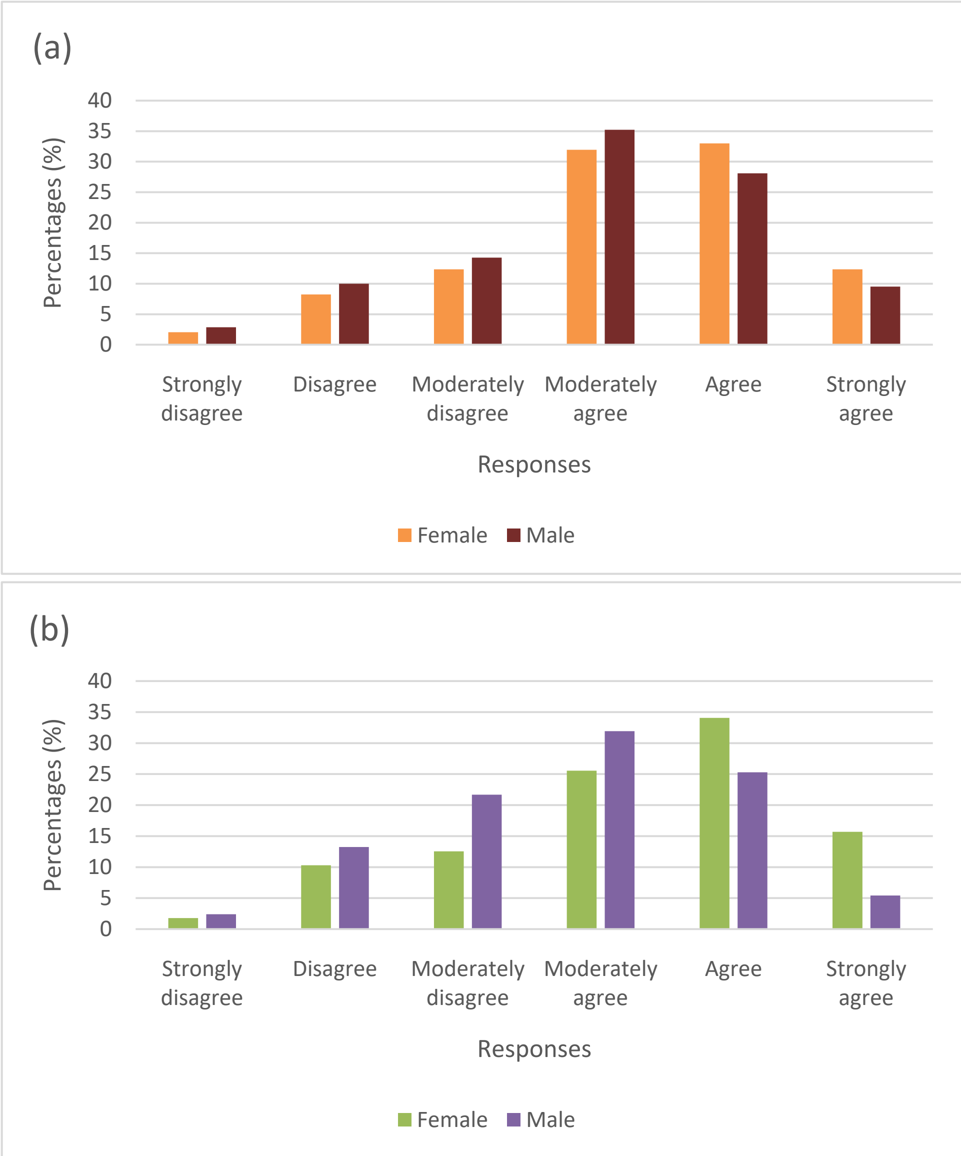

Figure 3. Responses to statement "My family encouraged me to choose this field of study" by gender of engineering (a) and non-engineering STEM (b) students.

For the statement, "I am certain my studies will be beneficial for my future career," for both engineering students (Table 2) and non-engineering STEM students (Table 3). The results show strong agreement across both groups and genders. Although the strongest agreement was observed among women engineering students, the difference was not statistically significant ($p = 0.13$). In contrast, for the non-engineering STEM students the result is significant with a p-value < 0.05, although the effect size is relatively small and represents only weak association.

Table 2. Comparison of motivation for choosing field of study between female and male engineering students.

Statement	"I chose this field of study because I am passionate about it"		"I chose this field of study because it is valued by my community"		"My family encouraged me to choose this field of study"		"I am certain my studies will be beneficial for my future career"	
Cohort	Female	Male	Female	Male	Female	Male	Female	Male
Average	4.85	4.95	3.36	3.40	4.23	4.04	5.22	5.05
% Agreement	91	95	42	47	77	73	98	95
χ^2(df, n); *p*-value	7.66 (5, 307); 0.18		4.35 (5, 307); 0.50		1.81 (5, 307); 0.87		8.43 (5, 307); 0.13	
Cramer's V [95% CI]	0.16 [0.10,0.28]		0.12 [0.08, 0.26]		0.08 [0.06,0.22]		0.17 [0.10,0.26]	

Table 3. Comparison of motivation for choosing field of study between female and male non-engineering STEM students.

Statement	"I chose this field of study because I am passionate about it"		"I chose this field of study because it is valued by my community"		"My family encouraged me to choose this field of study"		"I am certain my studies will be beneficial for my future career"	
Cohort	Female	Male	Female	Male	Female	Male	Female	Male
Average	4.84	4.96	3.36	2.95	4.27	3.81	5.01	4.75
% Agreement	88	97	45	37	75	63	94	91
χ^2(df, n); *p*-value	13.00 (5, 389); 0.02		14.37 (5, 389); 0.01		17.95 (5, 389); < 0.01		12.28 (5, 389); 0.03	
Cramer's V [95% CI]	0.18 [0.13,0.27]		0.19 [0.13,0.30]		0.22 [0.15, 0.32]		0.18 [0.11,0.28]	

Overall, female engineering students showed the highest percent agreement, while male non-engineering STEM students showed the lowest with the statement "I am certain my studies will be beneficial for my future career". Descriptively, within both discipline cohorts, the females agreed with the statement more strongly than their male peers. From the point of view of expectancy-value theory, female respondents value the outcome of their studies, and they expect to succeed in achieving their career goals [7]. Their expectancy of a good career may be associated with the salary for jobs in STEM being relatively higher than jobs in other sectors that are traditionally available for women [35], and particularly high for graduate engineers. For the non-engineering STEM students, the specific fields of study of the female respondents may be important. Many of the female respondents were enrolled in study programs, such as science education, pharmacy, midwifery, nutrition, and psychology. In Indonesia, jobs in, for example, nutrition, child health and counselling, are dominated by women [36]. These are also fields of study that are more directly vocational and lead to a specific career. Hence, it is understandable that the stronger agreement expressed by female non-engineering STEM respondents may reflect their alignment with specific career trajectories that offer perceived opportunity for women.

Summing up, within the engineering cohort, very few gender differences were observed, and none that were statistically significant. Both male and female engineering students expressed equal enthusiasm for their chosen fields and received comparable levels of family encouragement. It is worth noting that there was no difference in level of family encouragement for females and males, and females expected a promising career in engineering, despite the stereotype that engineering is more suitable for males [3]. The women engineering students did not give different patterns of responses to the males.

Among non-engineering STEM students, there were significant differences for all questions. However, it is important to note that the effect sizes were small, indicating that these differences are modest and represent weak associations between gender and responses. Descriptively, male participants tended to show greater passion for their field of study, whereas female participants were more influenced by community values and family encouragement, and had greater certainty that their degree would be of benefit to their career.

Overall, the gender differences between male and female engineering students are much smaller than between male and female non-engineering STEM students, which may be associated with more similar expectancies for success and more aligned values, such as prestige, within the engineering cohorts [5]. The gender differences for the non-engineering STEM students may be associated with the different career opportunities or fields of study, as this grouped category includes a diverse set of disciplines with different gender norms, career trajectories, and participation patterns. However, other factors may also contribute and warrant further investigation.

3.2 Confidence in the future

We analyzed the responses to the statement “I am confident about my future because of my STEM degree”. This question addresses students’ optimism about their future, as it relates to their current studies. Understanding optimism is important because it can help students persist when facing challenges. Confidence is related to motivation, because students who are already motivated are more likely to develop confidence, which in turn can lead to sustained engagement over time [37]. Within the framework of expectancy-value theory, the confidence students have in their own ability to succeed shapes their expectancy beliefs [9]. As with the questions about motivation, we compared engineering to non-engineering STEM students, and male to female students within those two cohorts.

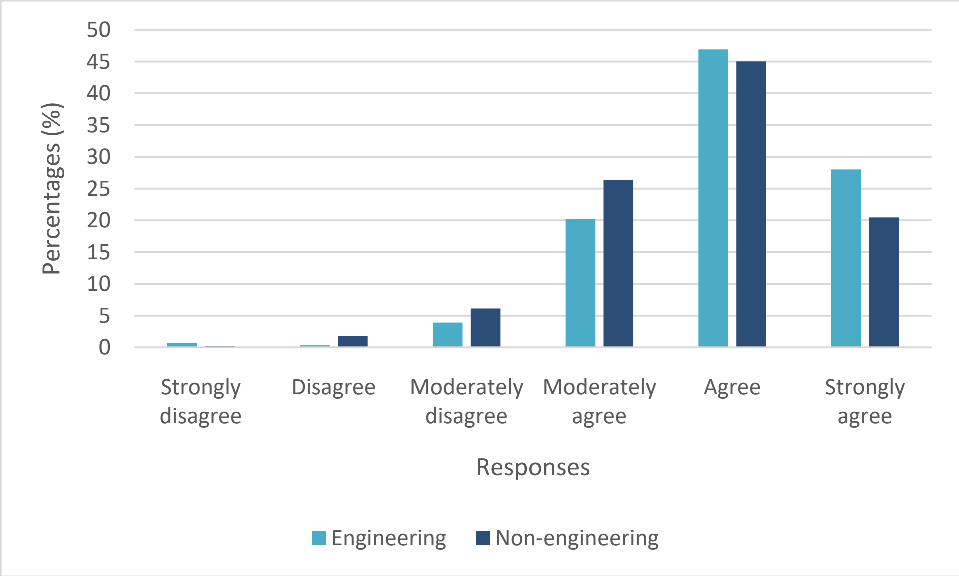

Figure 4. Responses to statement "I am confident about my future because of my STEM degree" by study program, comparing engineering and non-engineering STEM students.

Figure 4 demonstrates the optimism expressed by both engineering and other STEM students regarding their future. The most common response to this statement was “agree” for both engineering and other STEM students. While for both groups the level of agreement was high, a chi-square test indicated a statistically significant association between field of study and confidence in the future (see Table 4). This difference suggests that engineering may be perceived as offering more secure career pathways. Engineering is often viewed as a prestigious field associated with development of modern industrial systems [38]. However, the effect size was small, suggesting that the difference between groups is modest and of limited practical significance.

In Figure 5, we can see that among both engineering students (Figure 5a) and students from other STEM fields (Figure 5b), the female students generally agreed slightly more strongly than the males with the statement. The difference in the distributions was significant for non-engineering STEM students but not engineering students (Table 4). A statistically significant association was observed between gender and confidence in the non-engineering STEM group, however, the effect size was small, indicating a weak association and limited practical difference. On the other hand, no statistically significant association was observed between gender and confidence among engineering students, indicating similar response distributions across genders. This pattern may be associated with the absence of significant difference in the salaries received by entry level male and female STEM graduates in Indonesia, compared to the gender pay gap of approximately 23% across all types of employment [39]. The understanding that their professional opportunities and compensation are not hindered by gender-based differences, at least within the context of entry-level positions, may be associated with their optimism [40].

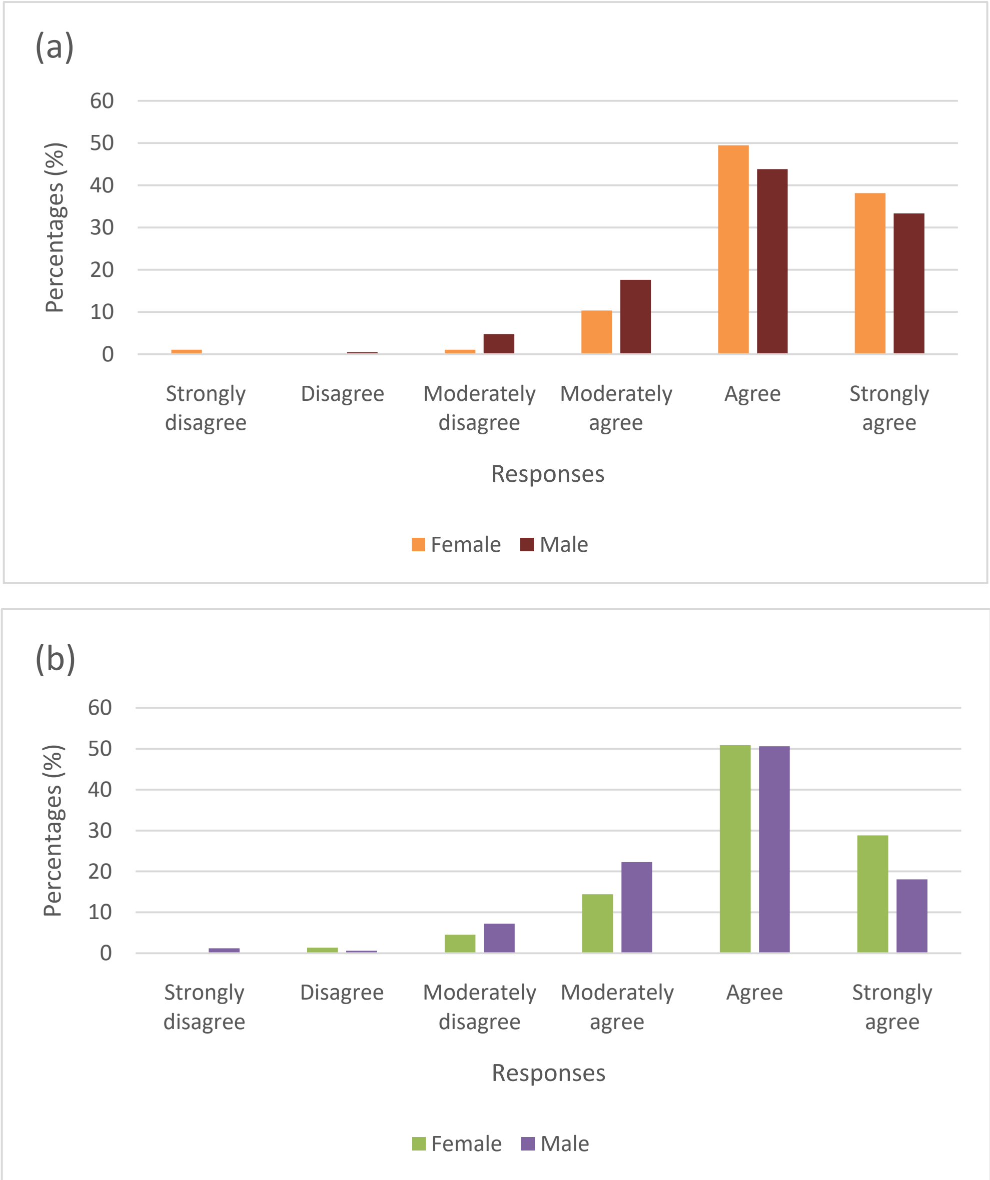

Figure 5. Responses to statement "I am confident about my future because of my STEM degree" by gender of engineering (a) and non-engineering STEM (b) students.

The data in Table 4 shows a high rate of confidence for all of the respondent groups. And again, we see a statistically significant gender difference for students in non-engineering STEM fields, although the effect size was small, but not for engineering students. In some respects, female engineering students appear more similar to their male peers than female non-engineering STEM students do to theirs. Additionally, female student participants who chose to study engineering were entering a male-dominated field, suggesting they may already represent a group characterized by comparatively higher confidence.

In contrast, many of the non-engineering STEM fields represented in the sample, for instance health and science education, tend to be associated with relatively lower wages [41]. For women, these roles may still be financially preferable compared to domestic responsibilities. However, for men in Indonesia, who often bear the responsibility of being the primary breadwinner in a family, low-paying jobs may be linked to lower confidence about their future [42]. Moreover, these are fields that are female dominated which may be more culturally comfortable for women. In Eccles' expectancy-value framework, gender-roles as influenced by social environment can shape attainment value [43], and this includes encouraging women to value caring more than men [44,45], which may be associated with their motivation in choosing a future career.

Table 4. Responses to the statement "I am confident about my future because of my STEM degree" by respondents' field of study and gender, comparing engineering and non-engineering STEM students, female and male engineering students, female and male non-engineering STEM students.

Cohort	Eng.	Non-Eng. STEM	Female (Eng.)	Male (Eng.)	Female (Non-Eng. STEM)	Male (Non-Eng. STEM)
Average	4.96	4.75	5.11	4.90	4.86	4.62
% Agreement	96	93	98	94	93	91
χ^2(df, n); *p*-value	12.51 (5, 697); 0.05		6.58 (5, 307); 0.25		11.89 (5,389); 0.04	
Cramer's V [95% CI]	0.14 [0.09,0.22]		0.15 [0.10, 0.26]		0.17 [0.11, 0.28]	

We found many responses to open-ended questions that illustrate the observation that these students are optimistic about their futures. Participant 280, a female engineering student, stated, "*I'm confident that engineering majors can thrive anywhere*". Similarly, Participant 71, a male engineering student, expressed the same enthusiasm: "*The future seems promising.*" Participant 544, a female non-engineering STEM student, wrote, "*It makes it easier for me to achieve my dreams*", while Participant 317, a male non-engineering STEM student, shared, "*I'm optimistic about a bright future*".

To summarize, the quantitative data showed that confidence in future prospects varied across disciplines. Descriptively, engineering students expressed higher levels of confidence in their future compared to non-engineering STEM students. This may be associated with the perceived security and prestige of engineering career pathways in Indonesia, which are often reinforced by industry partnerships and government initiatives [46]. There was no significant difference by gender for the engineering students. In contrast, among non-engineering STEM students, female participants descriptively reported greater confidence in their future than male participants.

4. Conclusions

This research addresses the research questions "What factors shape the motivation of engineering and non-engineering STEM students, and how do these differ by gender?" and "How do engineering and non-engineering STEM students, across gender groups, differ in their confidence about their future?". The findings revealed diverse motivational drivers and varying degrees of confidence in future prospects of undergraduate students pursuing engineering and non-engineering STEM programs in Indonesia. While passion for their chosen fields and family encouragement was consistent across both groups, reflecting comparable intrinsic and attainment value, distinctions were found in other sources of motivation and confidence. Among students in the aggregated non-engineering STEM group, males exhibited stronger intrinsic value, while females were more driven by utility and attainment value, and reported higher confidence in their future. These patterns suggest that external support systems and career clarity may be associated with optimism. Finally, confidence in their future was high for all respondents, but higher among engineering than other STEM fields students, and higher for female non-engineering STEM students than male non-engineering STEM students. We suggest that institutions consider whether expanding support networks and improving the clarity of career pathways could strengthen student motivation and confidence, while recognizing that these are suggested by observed patterns rather than direct testing of these relationships. Nevertheless, these findings should be interpreted with caution, as the non-engineering STEM category encompasses a heterogeneous set of disciplines.

5. Limitations and future work

Inevitably, this study has several limitations. The survey relied on voluntary participation, which may introduce self-selection bias, so it is likely that this research was unable to fully capture the perspectives of students who are disengaged. In addition, because the survey was distributed through social media, participants were largely those who are socially active online, limiting insight into students who are socially isolated or disconnected from major networks. Furthermore, the cross-sectional design limits the ability to draw causal conclusions. Longitudinal research would provide deeper insight into how students' experiences evolve over time. Socio-economic background was not measured in the present study; however, it is important to acknowledge that students' financial circumstances may intersect with their motivations and confidence in pursuing STEM degrees. Future research incorporating socio-economic indicators would provide a more comprehensive understanding of how structural conditions interact with individual motivations among Indonesian STEM students.

An important limitation of this study is the aggregation of diverse non-engineering STEM disciplines into a single category. Fields, such as pharmacy, psychology, nutrition, and science education, differ in terms of career pathways, gender representation, and student motivations. While this grouping was necessary to ensure sufficient sample sizes for statistical analysis, it may obscure discipline-specific patterns. Therefore, the findings for non-engineering STEM students should be interpreted as indicative of broad trends rather than precise representations of individual fields. Future research with larger or more balanced samples should examine these disciplines separately.

Additionally, the study is subject to potential social desirability bias, as participants may have responded in ways they perceived as favourable. Unequal subgroup sizes may also have influenced the stability of the statistical estimates. Finally, the survey items were treated as single-item indicators rather than validated multi-item scales, and the available evidence for their construct validity is limited. Future research would benefit from using instruments with stronger measurement validity.

Author contributions

Syifa Asatyas: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft; Kate Wilson: Conceptualization, Methodology, Investigation, Supervision, Writing – review & editing; Zlatko Jovanoski: Conceptualization, Methodology, Investigation, Supervision, Writing – review & editing.

Use of Generative-AI tools declaration

The authors declare the use of Microsoft Copilot for language editing, which was used to improve clarity and grammar. No AI tools were used to generate data, produce graphical elements, or make scientific decisions.

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Conflict of interest

The authors declare no conflict of interest.

Prof. Zlatko Jovanoski is an editorial board member for STEM Education and was not involved in the editorial review and the decision to publish this article.

Ethics declaration

Approval for this study was granted by the UNSW Human Research Ethics Advisory Panel (HREAP), project reference iRECS5685.

References

1. Asmara, A., Moses, K.M., Wardhana, A.S.J. and Irnanda, A.D., A Five-Year Trajectory of STEM Education Research in Indonesia: A Systematic Literature Review. In *the 6th International Conference of Ice-Elinvo 2023: Digital Solutions for Sustainable and Green Development*, *AIP Conference Proceedings*, 2025, 3281(1). https://doi.org/10.1063/5.0267530
2. Hazrat, M.A., Hassan, N.M.S., Chowdhury, A.A., Rasul, M.G. and Taylor, B.A., Developing a Skilled Workforce for Future Industry Demand: The Potential of Digital Twin-Based Teaching and Learning Practices in Engineering Education. *Sustainability*, 2023, 15(23): 16433. https://doi.org/10.3390/su152316433
3. Dart, S., Cunningham, S., Leydon, E., Woolston, B., Shirmohammadi, M., Long, S., et al., Why Students study STEM: Disciplinary and gender motivations. In *34th Australasian Association for Engineering Education Annual Conference Proceeding*, 2023.
4. Han, J. and Wang, Y., A Systematic Review of Graduate Students' Research Motivation: Themes, Theories, and Methodologies. *Educational Psychology Review,* 2024, 36(3): 87. https://doi.org/10.1007/s10648-024-09924-8
5. Schunk, D., Meece, J. and Pintrich, P., *Motivation in Education: Theory, Research, and Applications*, 4th ed. Pearson, 2014.
6. Nikolic, S., Ros, M. and Hastie, D.B., Teaching programming in common first year engineering: discipline insights applying a flipped learning problem-solving approach. *Australasian Journal of Engineering Education*, 2018, 23(1): 3–14. https://doi.org/10.1080/22054952.2018.1507243
7. Urhahne, D. and Wijnia, L., Theories of Motivation in Education: an Integrative Framework. *Educational Psychology Review*, 2023, 35(2): 45. https://doi.org/10.1007/s10648-023-09767-9

8. Wigfield, A. and Eccles, J.S., Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, 2000, 25(1): 68–81. https://doi.org/10.1006/ceps.1999.1015
9. Zucker, T., Montroy, J., Master A., Assel, M., McCallum, C. and Yeomans-Maldonado, G., Expectancy-value theory & preschool parental involvement in informal STEM learning. *Journal of Applied Developmental Psychology*, 2021, 76: 101320. https://doi.org/10.1016/j.appdev.2021.101320
10. Mammadov, S. and Tozoglu, D., Autonomy support, personality, and mindset in predicting academic performance among early adolescents: The mediating role of self-determined motivation. *Psychology in the Schools*, 2023, 60(10): 3754–3769. https://doi.org/10.1002/pits.22966
11. Prieto, E. and Holbrook, A., Why we should capitalise on early childhood interest in engineering: changes in students' interest over the school years. *Australasian Journal of Engineering Education*, 2021, 26(2): 155–166. https://doi.org/10.1080/22054952.2021.1928867
12. Chen, Y., Chiu, S.W.K., Zhu, J. and So, W.W.M., Maintaining secondary school students' STEM career aspirations: the role of perceived parental expectations, self-efficacy, and cultural capital. *International Journal of Science Education*, 2022, 44(3): 434–462. https://doi.org/10.1080/09500693.2022.2032463
13. Franklin, M., Brewe, E. and Ponnock, A.R., Examining reasons undergraduate women join physics. *Physical Review Physics Education Research*, 2023, 19(1): 010110. https://doi.org/10.1103/PhysRevPhysEducRes.19.010110
14. Veza, I., Farid, M., Said, M., Widodo, T., Riyadi, B., Abbas, M., et al., Issues in the Science and Engineering Education in Indonesia: How to Improve Competitiveness Through STEM Mastery. *International Journal of Advanced Research in Future Ready Learning and Education*, 2021, 24(1): 1–6.
15. Simarro, C. and Couso, D., Engineering practices as a framework for STEM education: a proposal based on epistemic nuances. *International Journal of STEM Education*, 2021, 8(1): 53. https://doi.org/10.1186/s40594-021-00310-2
16. Hunter, A., Why undergraduates leave STEM majors: Changes over the last two decades. In *Talking about Leaving Revisited Persistence, Relocation, and Loss in Undergraduate STEM Education*, 2019, 87–114. Springer. https://doi.org/10.1007/978-3-030-25304-2
17. Shin, S., Rachmatullah, A., Roshayanti, F., Ha, M. and Lee, J.K., Career motivation of secondary students in STEM: a cross-cultural study between Korea and Indonesia, *International Journal for Educational and Vocational Guidance*, 2018, 18(2): 203–231. https://doi.org/10.1007/s10775-017-9355-0
18. Lloyd, A., Gore, J., Holmes, K., Smith, M. and Fray, L., *Parental Influences on Those Seeking a Career in STEM: The Primacy of Gender*, 2018. Available from: http://genderandset.open.ac.uk
19. Bloodhart, B., Balgopal, M.M., Casper, A.M.A., McMeeking, L.B.S. and Fischer, E.V., Outperforming yet undervalued: Undergraduate women in STEM. *PLoS One*, 2020, 15(6): e0234685. https://doi.org/10.1371/journal.pone.0234685
20. Steele, W. and Rickards, L., *The Sustainable Development Goals in Higher Education: A Transformative Agenda?* Springer Nature Switzerland AG, 2021. https://doi.org/10.1007/978-3-030-73575-3
21. Asatyas, S., Wilson, K. and Jovanoski, Z., Studying Engineering in Indonesia: Challenges and

Supports. In *36th Australasian Association for Engineering Education Annual Conference Proceeding*, 2025, 108–116. Brisbane, QLD: Engineers Australia. Available from: https://aaee2025.org/microsite/pdf/full-paper_43.pdf
22. Faisal and Martin, S.N., Science education in Indonesia: Past, present, and future. *Asia-Pacific Science Education*, 2019, 5(1): 1–29. https://doi.org/10.1186/s41029-019-0032-0
23. Wilson, K.F. and Wilson, K., How do students in different minority groups experience first-year engineering? *Australasian Journal of Engineering Education*, 2020, 25(1): 66–78. https://doi.org/10.1080/22054952.2020.1796044
24. de Vaus, D., *Surveys in Social Research*, 6th ed. Routledge, 2014.
25. Kulas, J.T. and Stachowski, A.A., Middle category endorsement in odd-numbered Likert response scales: Associated item characteristics, cognitive demands, and preferred meanings. *Journal of Research in Personality*, 2009, 43(3): 489–493. https://doi.org/10.1016/j.jrp.2008.12.005
26. Chyung, S.Y.Y., Roberts, K., Swanson, I. and Hankinson, A., Evidence-Based Survey Design: The Use of a Midpoint on the Likert Scale. *Performance Improvement*, 2017, 56(10): 15–23. https://doi.org/10.1002/pfi.21727
27. Chen, Y., Johri, A. and Rangwala, H., Running out of STEM: a comparative study across stem majors of college students at-risk of dropping out early. In *LAK'18: International Conference on Learning Analytics and Knowledge*, 2018, 270–279. https://doi.org/10.1145/3170358.3170410
28. Jiang, Z., Tang, X., Tan, L., Su, R. and Wei, B., STEM identity and STEM career intention: a meta-analysis. *International Journal of STEM Education*, 2025, 12(1): 57. https://doi.org/10.1186/s40594-025-00578-8
29. Thiry, H. and Weston, T.J., Choosing STEM Majors. In *Talking about Leaving Revisited Persistence, Relocation, and Loss in Undergraduate STEM Education*, 2019, 115–136. https://doi.org/10.1007/978-3-030-25304-2
30. Teo, T.W., STEM Education Landscape: The Case of Singapore. In *Journal of Physics: Conference Series*, 2019, 1340(1): 012002. https://doi.org/10.1088/1742-6596/1340/1/012002
31. Gossen, D., It Says STEM so it must Work for Everyone: Experiences, Beliefs, and Career Choices across the STEM Disciplines. *International Journal of Education in Mathematics, Science and Technology*, 2024, 12(3): 660–681. https://doi.org/10.46328/ijemst.3450
32. World Bank Group Gender Data Portal, *Share of graduates by field, female*. Available from: https://genderdata.worldbank.org/en/indicator/se-ter-grad-fe-zs?fieldOfStudy=Engineering%2C+manufacturing+and+construction
33. Sya'bandari, Y., Aini, R.Q., Rusamana, A.N. and Ha, M., Indonesian students' STEM career motivation: A study focused on gender and academic level. In *Journal of Physics: Conference Series*, 2021, 1957(1): 012029. https://doi.org/10.1088/1742-6596/1957/1/012029
34. Herliani, E. and Karyana, S., Perception and Motivation of Female and Male Students Toward STEM in Indonesia. *SEAQIS Journal of Science Education*, 2021, 1(1): 18–26.
35. Zając, T., Magda, I., Bożykowski, M., Chłoń-Domińczak, A. and Jasiński, M., Gender pay gaps across STEM fields of study. *Studies in Higher Education*, 2025, 50(1): 126–139. https://doi.org/10.1080/03075079.2024.2330667
36. Vaezghasemi, M., Öhman, A., Ng, N., Hakimi, M. and Eriksson, M., Concerned and conscious, but defenseless - the intersection of gender and generation in child malnutrition in Indonesia: a qualitative grounded theory study. *Global Health Action*, 2020, 13(1): 1744214.

https://doi.org/10.1080/16549716.2020.1744214

37. Johnston, O., Wildy, H. and Shand, J., “Believe in me, and I will too”: a study of how teachers’ expectations instilled confidence in Grade 10 students. *Social Psychology of Education*, 2021, 24(6): 1535–1556. https://doi.org/10.1007/s11218-021-09668-1
38. Stefanov, S. and Stefanov, T., Restoring the prestige of engineering education through an engineering-led digital transformation of economic science. In *IEEE Global Engineering Education Conference*, 2023, 1–10. https://doi.org/10.1109/EDUCON54358.2023.10125111
39. Purnamasari, R., Weinnman-Sandig, N., Setia, R. and Town, S., *A Qualitative Study of Constraints Underlying Women’s Labor Force Participation in Indonesia: The Case of Java*, World Bank, Washington, DC, 2020.
40. Zhou, Y. and Shirazi, S., Factors Influencing Young People’s STEM Career Aspirations and Career Choices: A Systematic Literature Review. *International Journal of Science and Mathematics Education*, 2025, 23(7): 2895–2918. https://doi.org/10.1007/s10763-025-10552-z
41. Azmi, I.A.G., Ismail, S.H.S. and Basir, S.A., Women Career Advancement in Public Service: A Study in Indonesia. *Procedia - Social and Behavioral Sciences*, 2012, 58: 298–306. https://doi.org/10.1016/j.sbspro.2012.09.1004
42. Thébaud, S., Masculinity, bargaining, and breadwinning: Understanding men’s housework in the cultural context of paid work. *Gender and Society*, 2010, 24(3): 330–354. https://doi.org/10.1177/0891243210369105
43. Contreras-Ortiz, S.H., Del Valle, C.O., Marrugo-Salas, L. and Mart ńez-Santos, J.C., Expectancy-value, Stereotypes and Gender Role Beliefs in Engineering Students. In *Proceedings of the LACCEI international Multi-conference for Engineering, Education and Technology*, 2024, 2(11). https://doi.org/10.18687/LEIRD2024.1.1.872
44. Schmader, T. and Block, K., Why Do Women Care More & Men Couldn’t Care Less? *Daedalus*, 2025, 154(1): 82–97. https://doi.org/10.1162/daed_a_02125
45. Poole, M., Isaacs, D., *Caring: A Gendered Concept*, 1997.
46. Suwandaru, A., Alghamdi, T.and Nurwanto, N., Empirical analysis on public expenditure for education and economic growth: Evidence from Indonesia. *Economies*, 2021, 9(4): 146. https://doi.org/10.3390/economies9040146

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