

Research Article

The Role of the Academic Strand in Enhancing TVET Student Reasoning Skills Through Social-Emotional Learning Competency

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Abstract: This study focused on the role of the academic strand in enhancing TVET students' reasoning skills through social-emotional learning competency (SEL). This study employed a survey design, with data collected through a structured questionnaire. The study focused on 1,900 students pursuing various science, technology, engineering, and mathematics (STEM) programs. The sample covers 320 students drawn from a population of 1,900. The study utilized stratified simple random sampling techniques. The data was analyzed using Structural Equation Modeling (SEM) run in IBM Amos (v23) to estimate the hypothesized paths. The researcher elaborated this study by adding a mathematical model (SEIR-like). The research findings indicated that SELC has a significant influence on reasoning skills. Moreover, SELC demonstrated a considerable positive effect on the academic strand. Additionally, the academic strand showed a notable positive effect on reasoning skills. Furthermore, the academic strand partially mediates the bond between SELC and the academic strand. Finally, the academic strand positively moderates the bond between SELC and the academic strand. The significant effect of SELC on reasoning skills suggests that schools can create dedicated SELC modules or integrate SELC-focused tasks into subjects like mathematics, science, and languages to nurture reasoning and critical thinking alongside emotional intelligence. Existing studies have paid limited attention to the mediating and moderating effects of academic strands on the bond between SELC and reasoning skills in a single study.

Keywords: academic strand; reasoning skills; social-emotional learning competency (SEL); TVET student

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1. Introduction

In the 21st century, technical and vocational education and training (TVET) has emerged as a crucial educational pathway to equip students with the skills necessary to meet the demands of the global labor market. However, in addition to technical competency, the development of reasoning skills and emotional intelligence has gained increasing importance as educators recognize the need for a more holistic approach to student learning and development (Estrada et al., 2021). Social-emotional learning competency (SEL) is one such approach that promotes skills that are vital for students' academic success and personal growth. This study explores the role of academic strand specialization in enhancing the reasoning skills of TVET students through SEL.

SEL has garnered significant attention over the past decades as an effective means to improve students' academic and personal outcomes. Social-emotional learning helps students develop crucial skills, such as empathy, resilience, self-management, and communication, which are essential for their success in both educational and professional environments. In a meta-analysis of over 200 studies conducted in the United States, Durlak et al. (2010) found that students who participated in social-emotional learning programs showed significant improvements in academic performance, social behavior, and emotional well-being compared to those who did not.

A study conducted by Wisniewski and Foster (2021) examined how integrating social-emotional learning into vocational education programs improved students' problem-solving abilities, collaboration skills, and emotional management. The study highlighted that

incorporating social-emotional learning into academic curricula positively influenced students' reasoning skills and overall cognitive development. In Asia, the significance of SELC has been emphasized in countries such as Singapore and South Korea, where educational systems focus not only on cognitive skills but also on the emotional and social dimensions of learning. Huang et al. (2023) conducted a study in South Korea that found that students who received SELC training showed enhanced critical thinking and decision-making skills, particularly in technical and vocational settings.

Academic strand specialization plays a pivotal role in TVET education as it allows students to focus on specific areas of interest, enhancing their technical knowledge and reasoning capabilities. Academic strands, such as engineering, hospitality, and information technology, provide students with opportunities to develop critical thinking and problem-solving skills tailored to their field of study.

In their context, the combination of SELC and academic specialization can significantly impact students' ability to reason and make decisions in complex, real-world situations (Xie et al., 2024). Research on SELC within TVET is gaining momentum. A study by Ibrahim and Nashir (2022) explored the impact of SEL on the critical thinking skills of TVET students in engineering strands. Their findings revealed that students with higher SELCs demonstrated better reasoning abilities and were better adapted to the demands of their specific vocational training. Similarly, Ochieng and Ngware (2022) found that the integration of social-emotional learning in TVET institutions enhanced students' decision-making processes, particularly in sectors requiring technical expertise and leadership skills.

In today's rapidly changing world, TVET plays a major role in equipping students with practical skills and competencies necessary for the workforce. However, there is growing evidence that cognitive abilities, particularly reasoning skills, are essential for students to apply their knowledge effectively in real-world scenarios (Johnsen et al., 2016). Reasoning skills encompass the ability to analyze information, draw conclusions, and solve problems, all of which are critical for success in technical fields.

Despite their importance, many TVET students exhibit deficiencies in reasoning skills, which can hinder their employability and career progression. Recent studies indicate that integrating SELC can significantly enhance students' reasoning skills. For instance, social-emotional learning programs improve students' cognitive engagement and critical thinking (Durlak et al., 2010). Similarly, students who participated in SELC interventions demonstrated improved problem-solving skills and academic performance (McClelland et al., 2017). These findings underscore the potential of SELC in fostering essential skills among TVET students.

A significant gap in the existing body of research lies in the interplay between reasoning skills, SELC, and academic strands among TVET students, a relationship that has not been thoroughly examined. Empirical studies exploring how academic strands moderate or mediate the connection between SELC and reasoning skills in this context are scarce. Current research tends to address these factors independently, focusing on SELC (Denham et al., 2014; Ülvey & Özkul, 2018), reasoning skills (Setiawan & Supiandi, 2018), or academic strands (Baret et al., 2024; Tura, 2022), without integrating them into a cohesive framework. The mechanisms through which SELC impacts academic strands and subsequently influences reasoning skills in TVET students remain unclear.

Additionally, there is a lack of intervention studies that systematically implement and evaluate strategies to enhance SELC and its effects on academic strands and reasoning skills. Addressing these gaps could offer valuable evidence-based strategies and practical insights for educators and policymakers. Therefore, this study aims to investigate how SELC enhances TVET students' reasoning skills and how academic strands may moderate and mediate this relationship. By investigating these gaps, the research will contribute to the development of effective educational strategies that promote reasoning skills through social-emotional learning, ultimately improving the employability and career readiness of TVET students.

To achieve the aim of this study, the following research objectives were formulated: (1) to examine the effect of SELC on reasoning skills; (2) to find out the effect of SELC on the academic strand; (3) to find out the effect of the academic strand on reasoning skills; (4) to analyze the mediating effect of the academic strand in the bond between SELC and reasoning skills; (5) to analyze the moderating effect of the academic strand in the bond between SELC and reasoning skills.

2. Literature Review

SELV is essential for the holistic development of students, promoting skills like self-awareness, self-management, social awareness, relationship skills, and responsible decision-making (Gimbert et al., 2023). Research indicates that these competencies positively affect various cognitive outcomes, including reasoning skills, which are crucial for TVET students in particular as they navigate problem-solving in practical and technical domains (Reimers et al., 2022).

Reasoning skills, encompassing critical thinking, problem-solving, and analytical abilities, are fundamental to success in TVET. These skills enable students to make informed decisions and adapt to the dynamic demands of technical fields (Hermans et al., 2024). Several studies highlight the need to develop reasoning skills in vocational education to improve students' performance in both academic and hands-on training (Frady, 2023). Research has begun to examine the specific effect of SELV on reasoning skills in TVET students. For instance, studies by Vasilev (2024) show that TVET students with higher SELV exhibit better performance in problem-solving tasks, particularly in technical and hands-on training.

These students also demonstrate improved teamwork and communication skills, which are critical for collaborative reasoning in vocational settings. A longitudinal study by West et al. (2020) found that social-emotional learning intervention targeting self-management and social awareness significantly improved students' analytical reasoning over time. The authors emphasized that the application of social-emotional learning in vocational education enhances students' ability to approach complex technical tasks with more structured and methodical thinking. Based on these reviews, the research hypothesized that SELV influences reasoning skills (H_1).

Social-emotional learning refers to the processes through which students develop emotional intelligence, interpersonal skills, and the ability to manage stress and social interactions effectively. According to Estrada et al. (2021), SELV has been proven to influence students' motivation, engagement, and overall academic success. In TVET programs, which emphasize practical skills and teamwork, SELV plays a critical role in helping students navigate both academic and workplace environments.

Different TVET academic strands may demand different sets of SELVs. For instance, Naukkarinen and Bairoh (2022) found that students in technology-focused strands, such as engineering or information technology, benefit greatly from strong problem-solving and self-management skills, which are part of SELV. These skills allow students to cope with complex technical challenges and collaborate effectively with peers in group projects. Admiraal et al. (2023) also conducted a longitudinal study on TVET students in various academic strands and found that social-emotional learning skills such as perseverance, emotional regulation, and stress management were significant predictors of program completion. Students who struggled with SELV were more likely to leave their programs, particularly in academic strands that involve high pressure and rigorous assessments. Based on these reviews, the researcher hypothesized that SELV influences the academic strand (H_2).

Several studies have examined how academic strands or specializations shape the cognitive and reasoning abilities of students. According to Tan et al. (2023), academic strands that emphasize mathematics, science, and technology tend to cultivate higher-order thinking and problem-solving skills. TVET students who engage in specialized technical courses often develop reasoning skills through applied learning and real-world problem-solving experiences. Nkambule and Ngubane (2023) also emphasized that students in technical strands within TVET programs demonstrate strong spatial reasoning and mechanical reasoning skills due to the practical nature of their curriculum.

In contrast to students in general, these academic strands may excel in abstract reasoning due to more theoretical instruction. TVET students typically receive more hands-on experience, which enhances their logical reasoning and practical problem-solving abilities. Also, research by Ngware et al. (2024) explored how the academic strands in TVET programs are aligned with the cognitive development of reasoning skills. The study revealed that students from technical academic strands, such as engineering or information technology, tend to outperform their peers in the general education strand when it comes to logical reasoning and decision-making under pressure.

Furthermore, academic strands in TVET that focus on vocational subjects tend to foster more context-specific reasoning skills, which may limit the student's ability to apply those skills in unrelated fields but enhance their effectiveness within the targeted vocational areas (Endende et al., 2022). El Fadil & Najar (2024) found that TVET programs that adopted inquiry-based learning or problem-based learning strategies saw significant improvement in students' reasoning capabilities. These pedagogies encourage students to analyze situations,

devise solutions, and justify their decisions, which are core components of reasoning. Based on these reviews, the researcher hypothesized that academic strand influences reasoning skills (H_3).

SELIC refers to the essential skills and abilities that enable individuals to effectively manage emotions, establish and maintain positive relationships, demonstrate empathy, set and achieve meaningful goals, and make responsible decisions. These competencies encompass five core areas: self-awareness, self-management, social awareness, relationship skills, and responsible decision-making. SELICs are critical for fostering resilience, emotional intelligence, and interpersonal skills, which are essential for personal development, academic success, and societal well-being. By cultivating these competencies, individuals are better equipped to navigate social and emotional challenges in various aspects of life.

On the other hand, an academic strand refers to a specialized track or pathway within an educational curriculum designed to align with students' interests, strengths, and future career aspirations. These strands often focus on a specific discipline or field of study, such as science, technology, engineering, and mathematics (STEM), humanities, arts, or business. Academic strands provide students with targeted learning experiences, enabling them to acquire foundational knowledge and skills relevant to their chosen area of focus. This approach helps prepare learners for higher education or career opportunities by tailoring their academic journey to meet specific goals and industry demands.

Studies have examined the effect of SELIC on academic performance. For instance, Farmer and Adams (2021) found that SELIC, particularly self-management and decision-making, had a significant positive impact on students' problem-solving abilities in mathematics. Similarly, Voon et al. (2022) explored the relationship between SELIC and logical reasoning, showing that students with strong relationship skills were more capable of collaborative problem-solving, which is essential for complex reasoning tasks. Research in cognitive neuroscience also supports this connection.

Also, Garner and Legette (2024) demonstrated that in STEM-focused educational programs, students with strong SELIC are better able to apply their reasoning skills to problem-solving tasks. Their study found that the integration of emotional regulation and collaborative learning in STEM education reinforced development, as students were encouraged to engage in group problem-solving and critical analysis. Finally, Poulou and Garner (2023) also examined the effect of SELIC-focused curricula in interdisciplinary programs. Their findings suggested that the academic strand with an interdisciplinary approach, which combines subjects like language arts and mathematics, is the most effective. Based on these reviews, the researcher hypothesized that academic strand mediating SELIC and reasoning skills (H_4).

Academic strands refer to the subject-specific pathways or disciplines (e.g., STEM, humanities, social science, art, etc.) that students choose to pursue. These strands may influence how SELIC translates into reasoning skills. For instance, Wheeler et al. (2023) found that students in STEM fields, who often engage in abstract and quantitative reasoning, might benefit more from SELICs like perseverance and self-regulation in enhancing their reasoning abilities.

In contrast, students in humanities or arts might see greater benefits from competencies like empathy and social awareness, which support critical thinking and reflective reasoning. Pellas (2025) investigated the role of SELIC in enhancing problem-solving skills in different academic fields and discovered a stronger correlation in STEM subjects, where reasoning often involves logical and analytical thinking. Moreover, McCormick et al. (2021) conducted a longitudinal study examining how social-emotional learning interventions influenced reasoning skills across different academic tracks in high schools. Their results showed that while SELIC universally benefited reasoning skills, the magnitude of the effect varied across academic strands. STEM students demonstrated the largest gains in logical reasoning, whereas humanities students showed stronger improvement in critical thinking and critical reasoning. The researcher, therefore, proposed that academic strand moderating SELIC and reasoning skills (H_5).

Figure 1 illustrates the conceptual framework for this study. The main constructs were used to construct the conceptual framework. From the figure, SELIC serves as the independent variable, academic strand represents both mediating and moderating variables, and reasoning skills represent the dependent variable.

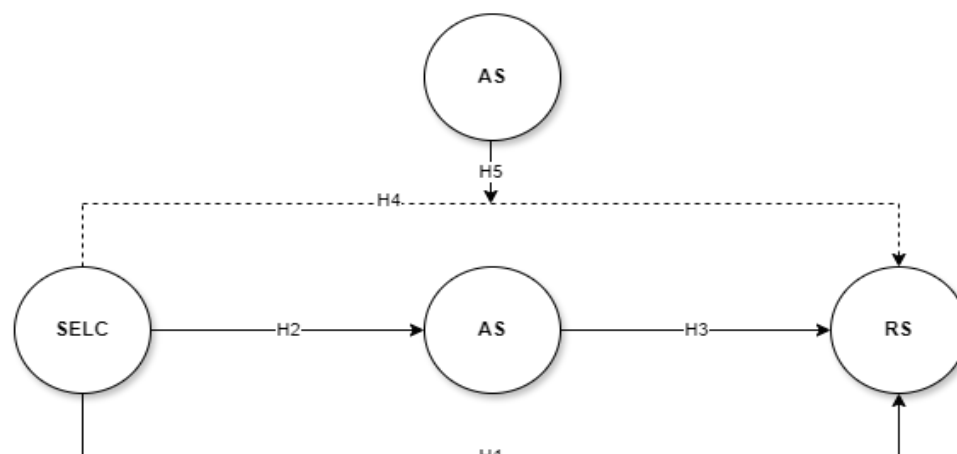


Figure 1. Conceptual framework of research.
Note: AS – academic strand; RS – reasoning skills.
Source: Authors’ constructs, 2025.

The reviewed literature demonstrates that SELC, academic strand, and reasoning skills are closely interconnected within the TVET educational context. Previous studies suggest that SELC contributes to students’ cognitive and analytical development, while academic strands may shape and strengthen this relationship through discipline-specific learning experiences. Therefore, this study seeks to further examine the direct, mediating, and moderating relationships among these variables in order to provide a deeper understanding of reasoning skill development among TVET students.

3. Materials and Methods

3.1. Research Design

A quantitative approach utilizing a cross-sectional survey was the chosen methodology for this study. According to Creswell (2009), a cross-sectional survey examines the bonds between constructs within a population during a particular time, where data was collected from participants at a singular, predetermined point in time.

3.2. Population, Sample Size, and Sample Techniques

The study focused on students pursuing TVET programs such as fashion design and textiles, wood technology, electrical engineering, and mechanical engineering at the University of Skills Training and Entrepreneurial Development (Kumasi, Ghana), comprising a total population of 1,900 students. The participants were undergraduate students (levels 100 to 300) from the Faculty of Technical Education and Vocational Education. This faculty was chosen because it offers core TVET programs, making it the most relevant setting for the study.

The study sample size was calculated using Krejcie and Morgan’s (1970) table, which estimated a sample of 320 from a population range of 1,900. Respondents were selected using stratified simple random sampling techniques. Firstly, the students were classified according to their program of study. Further, eighty students were randomly selected from each program of study, where yes and no were written on a piece of paper for students to select. Any student who selected yes was asked to respond to the questionnaire, while any student who selected no was not given the chance to respond to the questionnaire.

From table 1, it was clear that male respondents dominated the study, constituting 65.6%. For the age distribution, the dominant age group was 18 to 21 years, which constituted 53.1%. Similarly, 56.3% of the respondents are at level 100. Finally, there are equal percentages of respondents from each program of study, that is, 25% each

Table 1. Students’ background information.

Students background information	Response	Frequency (N)	Percentage (%)
Gender	Male	210	65.6%
	Female	110	34.4%
Age	18 years – 21 years	170	53.1%

Level of education	22-25 years	60	18.9%
	25-28 years	40	12.5%
	29 years and above	50	15.5%
	Level 100	180	56.3%
	Level 200	69	21.5%
	Level 300	71	22.2%
Program of study	Fashion design and textiles	80	25%
	Wood technology	80	25%
	Electrical engineering	80	25%
	Mechanical engineering	80	25%

3.3. Data Collection

Based on the study variables, the research questionnaire was designed with 34 items divided into four sections. Section I comprised the demographic information of the respondents, including gender, age, level of education, and program of study. Section II comprised items that measure SELC. The items were adopted from the work of Aygün & Taşkın (2022). Some of the Items were: “*I can identify my emotions when I struggle with math problems*,” “*I stay motivated to complete my math assignments even when they are challenging*,” and “*I am aware of how my classmates feel during math group activities*”. Moreover, section III comprised items that measure academic strands. The items were adopted from the work of Malaga and Oducado (2021). Some of the Items were: “*I feel engaged and interested in my mathematics classes*,” “*I regularly practice and apply the mathematical skills learned in class*,” and “*I received adequate support from my teachers regarding my mathematical learning*”. Finally, section IV comprised items that measure reasoning skills. The items were adopted from the work of Zulkipli et al. (2020). Some of the Items were: “*I often think critically about the reasoning behind mathematical procedures*,” “*I use logical reasoning to check the validity of my mathematical solutions*,” “*I am comfortable making conjectures based on my reasoning in mathematics*,” “*I receive adequate support from my teachers to develop my reasoning skills in mathematics*,” “*I participated in activities (math clubs, competitions) that enhanced my reasoning*,” and “*I seek out challenging problems that require deep reasoning in mathematics*”. The questionnaire comprised one independent variable, SELC, one mediating variable (academic strand), and one dependent variable (reasoning skills). The researcher utilized a five-point Likert scale of 1 = strongly agree to 5 = strongly disagree to evaluate the measurement items from section II to section IV.

Before the final data collection, a pilot survey was conducted to identify and rephrase unclear phrases in the questionnaire. To address the challenge of dispersed participants, both hardcopy and Google Form formats were employed, ensuring privacy and security for all participants’ data throughout the process. At the beginning of the questionnaire, we clearly outlined the study’s topic, the purpose of data collection, and the unique approach to addressing the research questions. Respondents were required to meet two primary criteria: (1) currently being a university student and (2) enrolled in a TVET program. Data collection occurred in July and August 2025, targeting students across selected TVET programs. The online survey was disseminated using the Google Forms platform, ensuring accessibility for participants. Additionally, the researcher facilitated data collection by delivering hard-copy questionnaires in person to selected departments. This dual approach ensured comprehensive participation and minimized barriers to data collection.

3.5. Data Analysis

Microsoft Office Excel 2019 was used to process the uploaded online survey data and code responses from hardcopy questionnaires. The dataset was then imported into IBM-SPSS (v.23) for exploratory factor analysis (EFA) and subsequently analyzed using IBM-AMOS (v.23) for confirmatory factor analysis (CFA). The EFA focused on identifying interrelated factors and produced a KMO statistic of 0.869, which exceeded the recommended threshold of 0.5 for factor analysis, as indicated by Hair et al. (2014).

According to Kaiser (1974), a KMO value above 0.80 is ideal for component analysis, reflecting a significant correlation among the items. Bartlett’s sphericity test further confirmed the adequacy of the dataset for factor analysis with a Chi-square value of 6407.603, degrees of freedom of 66, and a significant p-value of 0.000 ($p < 0.001$). The three extracted components accounted for 93.80% of the total variance explained, with the varimax rotation technique enhancing interpretability by reducing complex parameters and maximizing factor

loadings. The rotated component matrix revealed strong internal consistency across the constructs, as evidenced by Cronbach's alpha values.

For the overall scale, Cronbach's alpha was 0.913, while the constructs SELC, TVET students' reasoning skills, and academic strand had alpha values of 0.957, 0.961, and 0.982, respectively (see table 2), all exceeding the 0.7 benchmarks recommended by Ahmed and Ishtiaq (2021). This demonstrates a robust relationship among the components. The matrix loaded three observed items for SELC, three observed items for the academic strand, and six observed items for reasoning skills. Based on the rotated component matrix, items were critically assessed for retention or deletion before conducting CFA on the constructs using Amos (v.23) software. Figure 2 presents the overall research design process of the study. It illustrates the key methodological components employed in conducting the quantitative research.

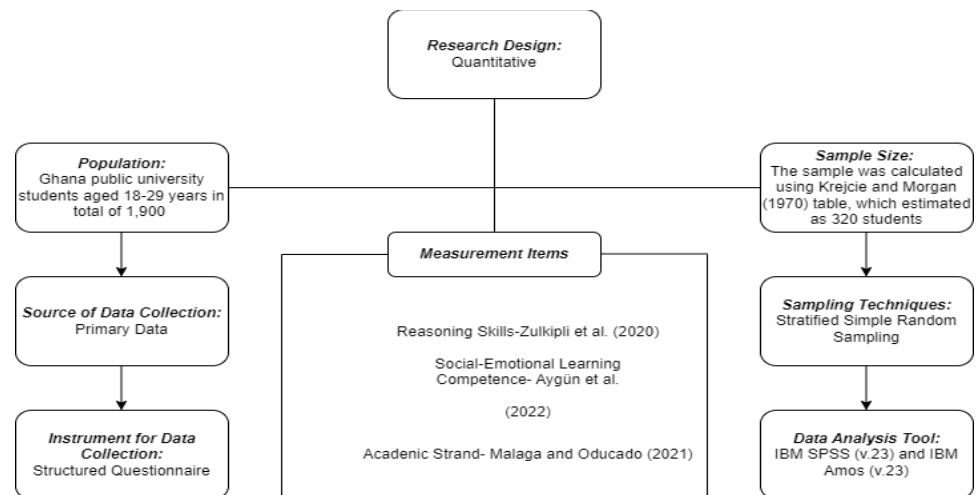


Figure 2. Design process.

Source: Authors' constructs, 2025.

3.6. Reliability and validity of the constructs

The structured questionnaire was subjected to content validity by giving it to the researcher's supervisor to examine whether the measurement items under its respective constructs measure what they are intended to measure. Moreover, the supervisor makes sure that the items are free from errors, bias, and inconsistencies and can be trusted to represent accurately the phenomena it is intended to measure. The items were audited and cross-checked with other items. CFA was performed using Amos (v.23) with the maximum likelihood estimation method, and the results are presented in table 2. The primary objective of the CFA was to evaluate the model's fit to the data for the study

Table 2. CFA results.

Model fit indices: CMIN = 76.272; DF = 39; CMIN/DF = 1.956; NFI = 0.988; TLI = 0.990; CFI = 0.994; RMR = 0.039; RMSEA = 0.052; PClose = 0.406;	Std. estimate
SELC: CA = 0.957; CR = 0.959; AVE = 0.886	
SELC5: I can identify my emotions when I struggle with math problems.	0.989
SELC7: I stay motivated to complete my math assignments even when they are challenging.	0.923
SELC8: I am aware of how my classmates feel during math group activities.	0.910
AS: CA = 0.961; CR = 0.962; AVE = 0.893	
AS1: I feel engaged and interested in my mathematics classes.	0.952
AS2: I regularly practice and apply the mathematical skills learned in class.	0.920
AS5: I received adequate support from my teachers regarding my mathematical learning.	0.963
RS: CA = 0.982; CR = 0.981; AVE = 0.896	
RS1: I often think critically about the reasoning behind mathematical procedures.	0.957
RS2: I use logical reasoning to check the validity of my mathematical solutions.	0.956
RS4: I am comfortable making conjectures based on my reasoning in mathematics.	0.940
RS8: I receive adequate support from my teachers to develop my reasoning skills in mathematics.	0.924
RS9: I participated in activities (math clubs, competitions) that enhanced my reasoning.	0.951
RS10: I seek out challenging problems that require deep reasoning in mathematics.	0.950

During the analysis, measurement items with poor factor loadings (below 0.5) were excluded to enhance model validity. In particular, seven measurement items were excluded from the SELC construct, seven items were eliminated from the academic strand, and four items were removed from the reasoning skills construct. Conversely, all twelve measurement items for the reliability construct demonstrated acceptable factor loadings and were retained.

The internal consistency of the retained measurement items was evaluated using Cronbach's alpha (CA). A minimum threshold of 0.7 was set as the acceptable standard for CA values, and all three constructs studied met or exceeded this criterion (table 2). This indicates that the retained measurement items for each construct exhibited adequate reliability.

Convergent validity was assessed using Average Variance Extracted (AVE) and Composite Reliability (CR) analyses. Following the guidelines of Fornell and Larcker (1981), convergent validity is achieved when the AVE of a construct exceeds 0.5, and its CR is at least 0.7. The results of this study confirmed that all constructs met these thresholds, thereby establishing convergent validity.

The fitness of the CFA model was evaluated using various fit indices. These indices included CMIN/DF; comparative fit index (CFI); root mean square error of approximation (RMSEA); root mean square residual (RMR); and PClose. According to Hair et al. (2014), the following criteria were used to assess model fit: CMIN/DF should be less than 3, CFI should be greater than 0.9, RMSEA and RMR should be less than 0.08, and PClose must be statistically insignificant at the 5% level ($p > 0.05$). The results, as summarized in table 2, indicated that the CFA model demonstrated an acceptable fit to the data. Figure 3 provides a diagrammatic representation of the CFA model.

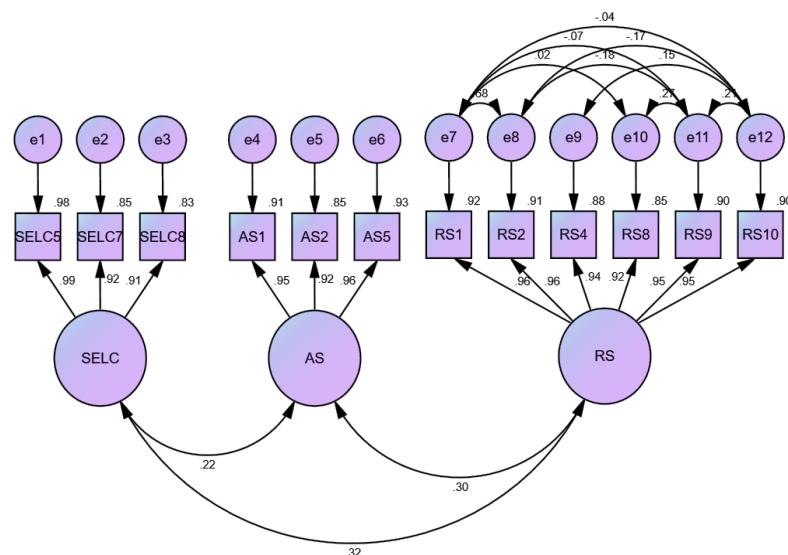


Figure 3. CFA model.

Note: AS – academic strand; RS – reasoning skills.

Source: Authors' constructs, 2025.

Discriminant validity was evaluated by comparing the square roots of the AVEs ($\sqrt{\text{AVEs}}$) with the intercorrelation scores among constructs, as recommended by past studies (Arthur et al., 2022; Asare & Larbi, 2025; Dogbe et al., 2023; Edo et al., 2024; Roemer et al., 2021). For discriminant validity to be established, the $\sqrt{\text{AVEs}}$ must exceed the corresponding intercorrelation scores. This criterion was satisfied in the current study, as shown in table 3. The lowest $\sqrt{\text{AVE}}$ recorded was 0.941 for the SELC, while the highest intercorrelation score was 0.323 between the SELC and reasoning skills constructs.

Table 3. Discriminant validity.

Variables	CR	AVE	SELC	AS	RS
SELC	0.959	0.886	0.941		
AS	0.962	0.893	0.222***	0.945	
RS	0.981	0.896	0.323***	0.302***	0.947

Multicollinearity, or the degree of correlation among independent variables, was also

examined. While some correlation between independent variables is expected, excessively high correlations (0.8 and above) indicate multicollinearity issues. In this study, the highest correlation was 0.323, which is well below the 0.8 threshold. Thus, no multicollinearity concerns were identified.

4. Results

The path analysis was conducted using AMOS version 23, employing a covariance-based structural equation modeling (SEM) approach. To enhance the robustness of the analysis, a bias-corrected percentile bootstrapping method was applied with 5,000 bootstrap samples at a 95% confidence level. The outcomes of the analysis are presented in table 4.

Table 4. Direct and indirect effects among SELC, academic strands, and reasoning skills.

Direct effect	Std. estimate	S.E.	C.R.	p-value
SELC→AS	0.222	0.044	5.045	< .01
SELC→RS	0.269	0.044	6.114	< .01
AS→RS	0.242	0.054	4.481	< .01
Direct effect	Std. estimate	S.E.	C.R.	p-value
Indirect Effect	Std. Estimate	Lower BC	Upper BC	p-value
SELC→AS→RS	0.062	0.033	0.108	0.000

At the same time, the structural model is illustrated in figure 4.

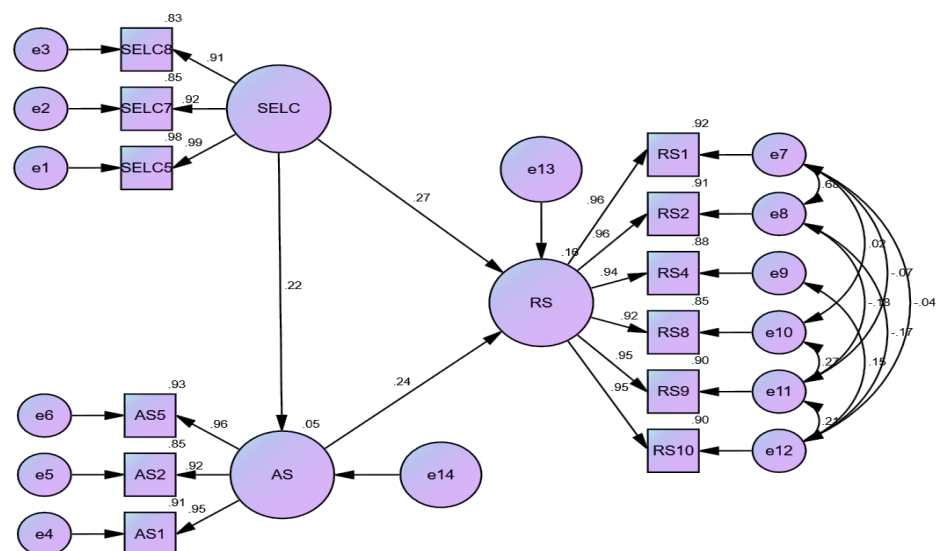


Figure 4. Structural model.

Source: Authors' Constructs, 2025.

According to the findings, SLEC has a significant positive effect on TVET students' reasoning skills ($\beta = 0.269$; $p < 0.01$). This suggests that engaging students in hands-on, collaborative activities where they take an active role in their learning fosters critical thinking and problem-solving abilities. Through experiential learning, students apply theoretical knowledge to real-world scenarios, enhancing their capacity to analyze, evaluate, and synthesize information. The collaborative aspect of SLEC further enables peer interaction and shared learning experiences, promoting deeper understanding and improved reasoning skills. This underscores the effectiveness of SLEC in equipping TVET students with essential cognitive competencies for academic and professional success. Thus, H_1 was accepted by this study.

Moreover, the results showed that SELC had a direct positive effect on the academic strand ($\beta = 0.222$; $p < 0.1$). This means that higher levels of SELC are associated with an increased likelihood of students selecting their preferred academic strand, suggesting that students' confidence in their ability to learn and achieve career goals plays a meaningful role in shaping their academic decisions. The p-value below 0.1 signifies that this effect is statistically significant, though at a slightly relaxed threshold, reflecting a noteworthy but moderate effect. Thus, H_2 was accepted by this study.

It was further identified that the academic strand had a direct positive effect on TVET students' reasoning skills ($\beta = 0.242$; $p < 0.1$). The p-value (< 0.1) shows that this relationship is statistically significant at the 10% level, which, while not as robust as stricter thresholds (e.g., $p < 0.05$), still provides evidence that the academic strand plays a meaningful role in shaping reasoning skills. This highlights the importance of tailoring academic content to foster critical thinking and problem-solving abilities within TVET contexts. Thus, H_3 was accepted.

Furthermore, an assessment was conducted to determine the indirect or mediating influence of the academic strand. Considering that both the lower and upper BCs were positive, the indirect effect's coefficient of 0.062 was determined to be statistically significant. It is believed that the academic strand partially mediates this nexus since SELC has a significant effect on TVET students' reasoning skills. Thus, H_4 was accepted by this study.

Finally, the study also examined the connection between SELC and reasoning skills, as well as the moderating effect of academic strands in this relationship. The moderating result is presented in table 5.

Table 6. Moderating result.

Moderating effect	Std. estimate	S.E.	C.R.	p-value
SELCAAS→RS	0.257	0.038	6.763	0.000

The study's findings indicated that the academic strand positively moderates the bond between SELC and reasoning skills, the standardized estimate coefficient for the path being 0.257, and its significance at a p-value less than 0.01. This supports H_5 , which suggests that the academic strand moderates SELC and reasoning skills.

From figure 5, SELC, academic strand, and the interaction term (SELCAAS) all had a direct positive effect on TVET students' reasoning skills. Moreover, the correlation between SELC, academic strand, and TVET students' reasoning skills was all positive.

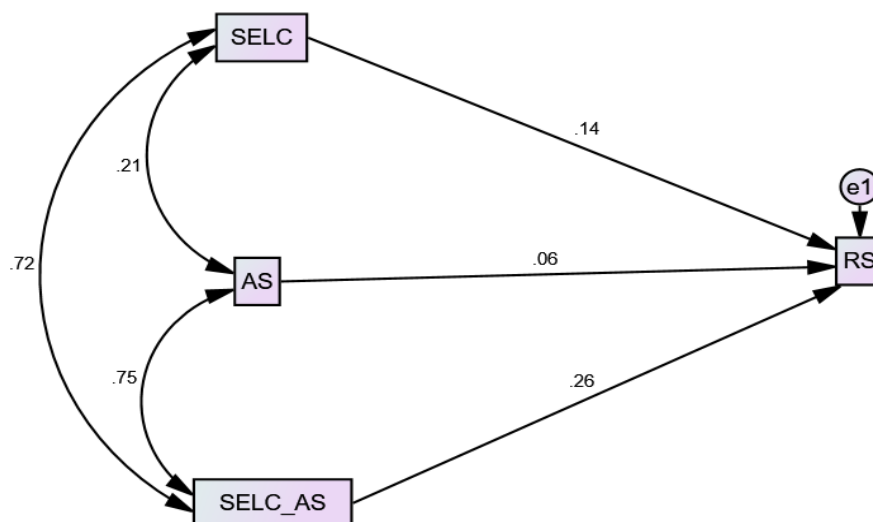


Figure 5. Moderating effect illustration.

Note: AS – academic strand; RS – reasoning skills.

Source: Authors' constructs, 2025.

Figure 6 illustrates the two-way interaction effect, where the academic strand moderates the relationship between TVET students' reasoning skills and their SELC. The figure shows that students in academic strands with higher levels demonstrate superior reasoning skills compared to those in lower academic strands. Furthermore, the academic strand strengthens the positive relationship between SEL and reasoning skills, indicating that SEL's impact on reasoning is more pronounced for students in academically rigorous strands.

The interaction effect underscores the significant role the academic strand plays in shaping the benefits of SEL on reasoning skills. When students engage in a high-level academic strand, they are likely to be exposed to more intellectually demanding and socially enriching environments, which may enhance their capacity to benefit from SEL programs.

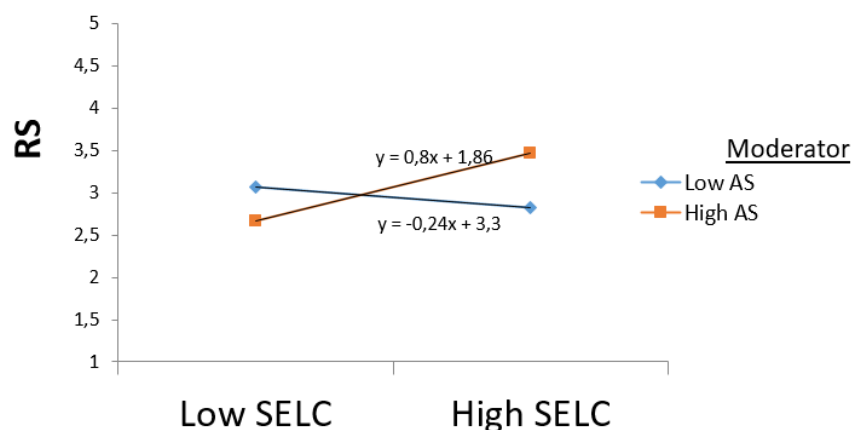


Figure 6. 2-way interaction moderating effect of academic strand moderating SELC and TVET students' reasoning skills.

Source: Authors' Constructs, 2025.

The findings suggest that educational interventions aimed at improving reasoning skills through SEL should consider tailoring strategies to the academic strand, as it influences the strength and effectiveness of the SELC and reasoning skills relationship.

5. Discussion

This section provides a discussion of results in line with the hypotheses of the study. The finding revealed that SELC has a significant effect on reasoning skills. This result suggests that improvement in SELC is associated with enhanced reasoning abilities among students. The results further explain that the relationship is not due to chance and that improving SEL skills has a direct and meaningful impact on cognitive processes like logical thinking, problem-solving, and decision-making. These skills are fundamental for academic performance and are equally vital in navigating complex life situations. This connection can be observed in how individuals with strong SEL skills approach challenges. For example, a student who can manage stress and empathize with peers is more likely to engage in collaborative problem-solving, leveraging diverse perspectives to arrive at logical conclusions. The study finding aligns with several studies that link SEL to reasoning skills. For instance, Martinez et al. (2022) found that SEL programs, when integrated into school curricula, not only improve emotional and social outcomes but also enhance students' cognitive abilities, including reasoning and problem-solving. These findings suggest that SELC fosters critical thinking by helping students regulate their emotions, which is essential in high-stakes cognitive tasks like reasoning. In a study by Nie et al. (2024), SEL was shown to improve students' academic performance through its positive effects on attention, self-control, and emotional regulation. Their findings suggest that these emotional competencies are linked to reasoning because they enhance students' ability to focus on tasks, manage stress, and make more informed decisions, all integral to reasoning.

Moreover, the analysis revealed that SELC had a significant positive effect on academic strands. This suggests that as students develop better social-emotional skills, there is a noticeable improvement in their academic performance across various subjects. SELC encompasses skills such as self-awareness, self-management, social awareness, relationship skills, and responsible decision-making. These skills allow students to navigate personal and interpersonal challenges more effectively, fostering a supportive learning environment. In essence, students with higher SELC are better equipped to handle academic stress, manage their time efficiently, and collaborate effectively with peers, leading to improved performance in different academic disciplines. This relationship is evident in classrooms where SEL-focused initiatives are implemented. For example, students taught to manage emotions during stressful situations, such as exams or group projects, often display resilience and problem-solving skills, directly boosting their academic outcomes. Several recent studies reinforce the findings of the current research. Soland and Kuhfeld (2022) demonstrated through a longitudinal study that SELC predicts academic success over time. They found that students with higher social-emotional skills were more likely to perform better academically throughout their schooling years. A comprehensive review by Elmi (2020) emphasized the

positive relationship between SEL and academic outcomes, highlighting that SEL is critical not only for students' personal development but also for their academic achievement. In a more focused study, Cuenca et al. (2023) demonstrated that SEL programs tailored to specific academic strands, such as STEM or humanities, had a direct and positive effect on students' performance in those subjects.

In addition, the study's findings revealed that the academic strand positively and significantly influenced reasoning skills. This bond underscores how tailored educational pathways, often emphasizing distinct skill sets like critical thinking, problem-solving, or analytical reasoning, contribute to enhancing students' reasoning abilities. For instance, a student in a STEM-focused strand may develop advanced logical reasoning through exposure to mathematics and science curricula, while students in the humanities may sharpen their verbal and critical reasoning through interpretive and analytical coursework. This insight emphasizes the importance of aligning educational pathways with the skill demands of various industries and societal needs. For instance, fostering reasoning skills through academic strands can directly prepare students for professional roles requiring high levels of analysis, such as engineering, medicine, or law. The study finding is consistent with a few earlier studies. For instance, Pease et al. (2020) found that students in STEM (Science, Technology, Engineering, and Mathematics) strands tend to develop higher levels of analytical reasoning compared to those in humanities strands due to the nature of STEM subjects, which often require systematic problem-solving and logical thinking. Similarly, Tumanger et al. (2024) identified that students in more quantitatively demanding academic strands, like mathematics and science, showed significant improvements in reasoning skills as a result of engagement with complex, abstract concepts. Moreover, Romero Ariza et al. (2024) highlighted that students in the social sciences and humanities, despite focusing less on numerical reasoning, developed strong skills in critical thinking and argumentation, another form of reasoning. This suggests that different academic strands enhance specific facets of reasoning, depending on the nature of the curriculum.

Furthermore, the results revealed that the academic strand partially mediates the bond between SELC and reasoning skills. The findings indicate that the academic strand plays a partial mediating role in the relationship between SELC and reasoning skills. This means that while SELC has a direct effect on reasoning skills, part of this effect is channeled through the academic strand. Essentially, the academic strand acts as a bridge that connects SELC to reasoning skills, enhancing the latter through improved academic engagement or performance. This partial mediation suggests that focusing solely on SELC is effective, but integrating academic development strategies alongside SELC may yield even greater improvements in reasoning abilities. Moreover, the results reveal a positive influence of SELC on the academic strand, emphasizing the interplay between emotional and social capacities and academic success. Students with strong SELC are more likely to demonstrate better academic habits, focus, and perseverance, which directly enhance their performance within the academic strand. This finding underscores the importance of fostering SELC in educational settings, as it not only supports emotional well-being and social interactions but also strengthens students' academic pathways, ultimately contributing to cognitive skills such as reasoning. Moreover, SELC positively influences reasoning skills, which is in line with the study of Ahmed et al. (2020), and academic strands positively influence reasoning skills, which is in line with the study of Peng and Kievit (2020). This study fills the gap in the literature by confirming that the academic strand positively and partially mediates the bond between SELC and reasoning skills, as no prior research has explored this specific mediating effect.

Finally, the study's results indicate that the relationship between SELC and reasoning skills is significantly influenced by students' academic strands. Specifically, students from academic strands that emphasize critical thinking and problem-solving, such as the science or mathematics tracks, demonstrated a stronger positive association between their SELC and reasoning skills compared to those in less analytical strands. This suggests that the academic context plays a vital role in shaping how SELCs translate into cognitive abilities. For instance, students in STEM-oriented strands may have more opportunities to apply emotional regulation, collaboration, and self-management skills in complex problem-solving situations, enhancing their reasoning capabilities. Furthermore, the findings highlight the interplay between SEL development and the cognitive demands of different academic pathways. Students in strands with rigorous intellectual challenges likely experience greater alignment between SELCs, such as empathy and decision-making, and their academic tasks, which often require logical reasoning and critical analysis. This moderation effect underscores the importance of tailoring SEL programs to fit the distinct academic contexts of students, as the

effectiveness of SEL in boosting reasoning skills may vary depending on the cognitive and practical demands of their chosen strands. This insight can inform educators and policymakers in designing SEL initiatives that leverage the strengths and needs of specific academic tracks.

6. Conclusions

The results of the study concluded that SELC had a significant positive influence on reasoning skills. It was further concluded that SELC had a significant positive influence on the academic strand. It was further concluded that the academic strand had a significant influence on reasoning skills. In addition, the study concluded that the academic strand partially mediates the nexus between SELC and reasoning skills. Finally, the study concluded that the academic strand positively moderates the nexus between SELC and reasoning skills. These findings indicate that teachers can improve students' reasoning skills by nurturing their SELCs, as these skills directly support both academic development and reasoning ability. The results also highlight the important role of the academic strand, which not only serves as a pathway through which social-emotional learning influences reasoning skills, but also strengthens this relationship. This means that when students' academic skills are well developed, the positive effect of social-emotional learning on their reasoning abilities becomes even stronger.

The findings of this study provide important theoretical and practical implications for education and cognitive development. Theoretically, the results confirm that SELC is closely connected with reasoning skills and academic development, supporting cognitive and emotional development theories that emphasize the interaction between emotional intelligence, academic pathways, and higher-order thinking. The mediating and moderating role of academic strands further demonstrates that cognitive outcomes are shaped not only by emotional competence but also by the academic environments in which students engage. Practically, the findings suggest that educational institutions should integrate SEL-focused activities into different academic disciplines, provide teacher training on SEL implementation, and design academic programs that strengthen both emotional competencies and reasoning abilities, particularly within strands that emphasize critical thinking and problem-solving skills such as STEM.

This study is limited by its cross-sectional design, reliance on self-reported data, and focus on a single institution, which may affect causality interpretation and generalizability. Future studies should involve multiple institutions, adopt longitudinal and mixed-method approaches, and incorporate additional data sources such as teacher evaluations or academic records to provide deeper and more reliable insights into the relationship among SELC, academic strands, and reasoning skills.

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Ethical Statement: The study was performed following the 2018 Ethical Guidelines for Educational Research by the British Educational Research Association.

Consent to Participate: Participation in this study was entirely voluntary. All participants were fully informed about the purpose, procedures, potential risks, and benefits of the research before data collection. They were assured of the confidentiality of their responses and their right to withdraw from the study at any stage without any penalty. Informed consent was obtained from all individuals before their participation.

Consent to Publish: The authors affirm that they have read and approved the final version of this manuscript and consent to its publication. All authors accept responsibility for the content of the article and agree to its submission to the journal.

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