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Social-Emotional Learning Competencies and Its Relation to Reasoning Skills: Moderating Effect of Academic Strand

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Abstract

Waning attention to the facets of social and emotional learning competencies (SELC) in an educational context along with the students' poor mathematical performance, which can be predicted through mathematical reasoning skills (MRS), is an issue that has to be addressed in the Philippines. Despite the fact that it has been shown to have an impact on mathematics achievement, associating SELC into the field of mathematical reasoning has yet to be explored. Hence, the study attempted to shed attention on the relationship between the perceived SELC of the respondents in terms of self-awareness, self-management, social awareness, relationship skills, and responsible decision-making and their level of MRS as to analyzing, generalizing, and justifying, and if strand moderates this relationship. A descriptive-correlational design with moderation analysis was used and stratified-random sampling technique was utilized in choosing 117 grade 12 students from one state university. Adapted self-report survey and mathematical reasoning tasks were used to gather data. The results revealed that there is a significant relationship between the perceived SELC and MRS, except in self-management and relationship skills. Findings have also suggested that strand moderates the relationship of the two variables which implies that the interaction of SELC and strands of the respondents poses a direct relationship with their reasoning abilities in mathematics, when students are from STEM. Implementation of teaching strategies fostering students' social and emotional states is recommended.

Keywords: *Social-Emotional Learning Competencies, Mathematical Reasoning Skills, STEM, non-STEM, CASEL*

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1. Introduction

Researchers across the years have explored different studies focused on variables to measure not just cognitive skills but also soft skills (Fonger et al., 2018; Inglis & Foster, 2018; Gokce & Guner, 2021) and social-emotional skills of the students (West et al., 2018). With the increasing attention on the different facets of learning, the Social and Emotional Learning (SEL) viewed social-emotional development as the interplay of five specific and interrelated competencies namely self-awareness, self-management, social awareness, relationship skills, and responsible decision-making (Collaborative for Academic, Social, and Emotional Learning, 2020). These social-emotional learning competencies (SELC) have become a growing field of educational research as international organizations, including the United Nations Educational, Scientific, and Cultural Organization (UNESCO, 2019), have also recognized its importance. They devised a 2030 agenda for Sustainable Development that divides student learning into dimensions which include domains of social and emotional, and behavioral development. Thus, the development of these skills in the classroom serves as the preparation of the students (OECD, 2019). However, only 20 states all over the world have integrated SEL into their educational curriculum (CASEL, 2020), and the Philippines is not one of those. In effect, although it was proven to have an impact on mathematical performance (Bhoumick & Saha, 2020) and the students' academic performance in general, West et al. (2018) stated that the social-emotional learning competencies are not assessed in school contexts. In fact, UNESCO (2019) stated that the social and emotional dimension has been given a declining emphasis across different educational levels until upper secondary.

Studies have shown the impact of SELC not just on students' academic performance in general but specifically on their mathematical performance (Kahl et al., 2021). In relation to this, mathematical performance is an important aspect that is recognized not just for educational purposes but also for preparation for future workplaces (National Council of Teachers of Mathematics, 2014). This highlights the significant role of mathematical reasoning skills (MRS) as they are a predictor of mathematical performance (Green et al., 2017). Even though mathematical reasoning is one of the essential proficiencies in mathematics education, educators still struggle to properly understand and assess the reasoning skills of students (Loong et al., 2018). To address this discrepancy, Loong et al. (2018) developed a rubric for

assessing the MRS of students based on three reasoning actions, namely analyzing, generalizing, and justifying.

According to the Research on Improving Systems of Education report in 2020, the SELC of students need further studies to understand the holistic development of learners including their mathematical performance, especially during distance learning (Yorke et al., 2021). Results of different international assessments in mathematics revealed that 60% of the students scored significantly below the average score set by international standards (OECD, 2018). It is also stated that grade 12 students scored the lowest points in the mathematics assessment (NAEP, 2019). In addition, the Philippines has been included in the low-performing countries for several years (World Economic Forum, 2017), even after the implementation of the K-12 curriculum, which includes the development of reasoning skills as part of the learning framework for the mathematics curriculum.

Researchers pointed out the importance of developing social-emotional skills during the transition of students from high school to college, as these skills improve their readiness for tertiary education (Dymnicki et al., 2013). The SELC and MRS of students were associated separately with other factors such as strand (Almerino et al., 2020). In the K-12 curriculum, this stage falls on the senior high school education of the students wherein students are grouped according to their strand as to who are enrolled in Science, Technology, Engineering, and Mathematics (STEM) courses and non-STEM courses, including those who are in Humanities and Social Sciences, Accountancy, Business and Management, and Technical-Vocational Livelihood track. Even though SELC and MRS are both related to mathematical performance, the relationship between the two variables is not yet explored. Thus, this study sought to determine if there exists a relationship between social-emotional learning competencies and mathematical reasoning skills of grade 12 students as moderated by strand.

2. Literature Review

2.1. Social-Emotional Learning Competencies

Social-Emotional Learning (SEL) can be achieved through the process of social-emotional development which leads to the acquisition of the social-emotional skills. These skills are not measured by cognitive assessments such as tests or exams but are proven to have an impact on students' academic performance (West et al., 2018). Taylor et al. (2017) found

that the benefits of SEL-based interventions in student outcomes have positive correlations with their skills and performance even after 18 years. Studies from different countries have also shown the positive impact of integrating SEL into classroom instructions in relation to the students' mathematical performance (Bhoumick & Saha, 2020). In fact, students with high social-emotional competence (SEC) profiles have shown greater mathematics performance in terms of achievement, attitude, and interest (Yang et al., 2019). Moreover, Kahl et al. (2021) found that the strategies to regulate emotion are linked with mathematical achievement across age groups and that the low working memory performance was compensated when they were knowledgeable about managing their emotions. However, Malti and Noam (2016) suggested that further research needs to be conducted to gain a better understanding of how several sub-dimensions of social-emotional development occur in children.

In the Philippine context, there were few studies focused on SEL. For instance, Rungduin and Reyes (2016) explored the development of kindergarten to grade 10 students from a social-emotional perspective. Chin (2018), on the other hand, has developed an instrument for measuring the social awareness competency of college students based on the SEL framework created by CASEL. Datu and Restubog (2020) further discussed the link between the dimensions of grit and SEL and revealed that perseverance and adaptability were positively correlated with SEL competencies.

2.2 Mathematical Reasoning

Another field that has become an area of interest in recent studies is mathematical reasoning, which predicts mathematical performance. Mathematical reasoning skill is a vital component of mathematics in a way that the higher the reasoning skill of the students, the faster they acquire the learning indicators of mathematics. Thus, it is the basic ability that influences performance in mathematics (Hasanah et al., 2019). The National Council of Teachers of Mathematics (2014) promotes the development of necessary knowledge and skills that students need, especially in high school that includes reasoning.

Different dimensions of reasoning were studied in relation to mathematical performance. Green et al. (2017) assert that fluid reasoning, the ability to analyze open-ended problems, recognize patterns and generalizations, and use logic to support arguments, predicts mathematical performance. Jonsson et al. (2022), on the other hand, concluded that creative

mathematical reasoning resulted to an improved mathematical performance. They also stated that the reasoning ability especially the creative reasoning is a stable pattern of educational strategy that positively affect math performance. Moreover, open-ended and creative tasks are generally more effective than algorithmic-based tasks when students demonstrated creative reasoning by prioritizing what they can observe in the illustrations given in their tasks (Mueller et al., 2014; Sullivan & Davidson, 2015; Norqvist et al. 2019).

2.3 Social-Emotional Learning Competencies and Mathematical Reasoning Skills

Studies about SELC and MRS revealed that they are both related to mathematical performance. For example, Verma and Dubey (2020) found that mood states or emotions have a significant effect on the reasoning ability of adolescents and concluded that providing either positive or negative feedback to students influenced their emotions affecting their performance. Martinez-Sierra (2015) indicated that emotions students feel while taking a test may affect their performances. It may vary from positive and negative emotions but, the ability to become aware of these emotions was reported to develop, together with cognitive skills like reasoning and problem-solving, as students age (Demetriou et al., 2020). Moreover, Roth (2016) also argued that mathematical reasoning is social in nature. Students should engage in either written or verbal forms of reasoning when attending mathematics classes. Similarly, students' decision-making skills are influenced by their mathematical reasoning and competence (Pertl et al., 2017). Having good reasoning skills makes decisions to be deeper and more constructive because it was based on supported claims.

2.4 Strand

Strand is one of the variables that is linked with the studies of SEL. Cuy and Salinas (2019) studied the aspirations and readiness of Filipino senior high school students attributed to SELC including self-motivation and time management for self-management, decision-making skills for responsible decision making, and understanding academic strengths for self-awareness. They found significant differences in perceived levels of aspiration and readiness when grouped according to academic track. The HUMSS strand, which is a non-STEM strand, showed the highest level of readiness.

In another study by Almerino et al. (2020) on the academic performance of grade 12 students in the Philippines, students from the STEM strand dominate in terms of non-verbal

reasoning and mathematical capacity. In general, students from STEM are above-average on tests about nonverbal reasoning, quantitative reasoning, reading vocabulary, reading comprehension, mathematical capacity, and mathematical applications. Students from HUMSS and GAS obtained above-average scores, while students from TVL had below-average scores. In relation to this, Cerbito (2020) discovered that there exists a significant relationship between senior high school students' attitudinal factors in mathematics and their proficiency in the subject. Indicators of attitude towards mathematics include their motivation, value, confidence, and enjoyment, which are also social-emotional in nature. He also found significant differences in the attitudes and performance of SHS students in mathematics when they are grouped according to their strands; STEM students demonstrated highest means in terms of attitude and mathematics test scores. A positive correlation between the two variables implies good attitudes towards mathematics predict high level of proficiency in the subject. Therefore, it can be inferred that the strand or track where SHS students are enrolled in could have affected the relationship between affective states and mathematical skills.

MacCann et al. (2020) also found that emotional intelligence (EI) predicts the academic performance of the students. Specifically, the ability to manage, understand, perceive, and use emotions for better decision-making has significant relationship with their achievement. Moderators of relationship between EI and academic performance were also studied. One of these potential moderators was the students' subject areas, particularly mathematics/sciences and humanities. In this regard, students from STEM and non-STEM also take different courses which are more inclined with mathematics and arts and social sciences, respectively. This may support the present study in trying to determine whether strand could have a moderating effect on the relationship between SELC and MR skills.

2.5. Theoretical Framework

Control-value theory states that the SELC of the students could affect their mathematical performance and achievement in aspects of control and value (Pekrun, 2006). The perceived control of the students towards a mathematical task is a result of their self-awareness. If they are aware on their ability to deal with the mathematical task, this will lead them to feel emotions towards it. These emotions are also related to their perceived value on mathematics tasks which may differ in accordance to their interest. These aspects of control and value may lead them to feel positive emotions such as enjoyment and motivation, or

negative emotions such as worry and anxiety in doing a mathematical task. From these emotions, the students' self-management skills may lead them to make responsible decisions on what to do with the task such as thinking of the best strategy to apply on it or skipping the math items that may take so much time to answer. Thus, if the students are aware that they are able to answer a mathematical problem, they will perceive a high level of control and value towards it. As a result, they may feel motivated while answering which will lead to a high performance. On the other hand, if the students are aware that they are not capable of dealing with the task, they may feel anxious towards it which will lead them to perceive a low level of control and value and end up with a low performance.

3. Methodology

3.1. Research Design

This study utilized a descriptive-correlational research design with moderation analysis. The descriptive design was used to describe and study the specific trends and differences SELC and MRS of the respondents (Loeb et al., 2017). The correlational research design is also used to examine if an increase or decrease in SELC corresponds to an increase or decrease in MRS (Tan, 2014). Finally, a moderation analysis was integrated to the design in order to determine whether strand moderates the relationship between the two variables (Holland et al., 2017).

3.2. Population and Sampling

The participants in this study are the grade 12 students of one state university in Laguna, Philippines. The sample was selected through stratified random sampling. The respondents who were enrolled in the second semester of the academic year 2021-2022, were divided into two strata namely STEM and non-STEM. A simple random technique was used to select 53 respondents from a total of 62 students from the STEM strand. On the other hand, out of 147 students from the non-STEM strand, 64 students were selected. All of the 117 respondents were coded as Student 1 to Student 117 to ensure confidentiality in analyzing the data gathered from them.

3.3. Instrumentation and Data Gathering Procedure

The study adapted the Washoe County School District – Social and Emotional Competency Assessment (WCSD-SECA), with established evidence for validity (Crowder et al., 2019) and reliability showing coefficient of α=0.68 to 0.74 (Davidson et al., 2017) indicating acceptability and suitability for use (Ursachi et al., 2015). Regarding the mathematical reasoning test, four mathematics teachers and one language teacher checked the tasks' guide questions in terms of their face and content validity. A pilot testing was conducted to ensure that the rubrics assesses the grade 12 students' level of reasoning skills.

Permissions from the college dean, principal and the teachers involved in Senior High School at the university were solicited regarding the conduct of the study and the participation of the grade 12 students. Upon approval, the researchers scheduled an online meeting with the students through Google Meet at their most convenient time, in which they were encouraged to open their cameras while answering. They were briefed on the purpose of the study and given an overview of how they will respond to the survey and test. Due to a conflict in their time availability, the survey which is answered for 30 minutes and the mathematical reasoning tasks which were answered in 90 minutes, were first administered to STEM students, followed by non-STEM students through Google Forms.

3.4. Ethical Considerations

In this study, all participants gave their consent and acknowledged having received complete information about the research procedures. All information of the respondents was kept confidential. To ensure their privacy and anonymity, the participants were coded Student 1, Student 2, and so on.

3.5. Data Analysis

Descriptive statistics were used to analyze the categorical and continuous variables of the study (Kaur et al., 2018). The variable strand (STEM and non-STEM) was analyzed by its frequency. The perceived SELC (very low, low, high, and very high) and level of MRS (not evident, beginning, developing, consolidating, and extending) were analyzed through mean and standard deviation of each component. To analyze the relationship between the variables,

Pearson Product-Moment Correlation was used (Tan, 2014). A moderation analysis with Process Macro was also used to determine if a moderating effect of strand exists in the relationship between SELC and MRS (Holland et al., 2017). After analysis, the findings were interpreted and necessary conclusions were provided.

4. Findings and Discussion

Table 1 illustrates the perceived SEL competency of the respondents. In terms of self-awareness, it was interpreted as high with a mean of 3.05. It can be understood that they find it easy to understand their emotions, thoughts, and behaviors in various contexts. This result is in line with the findings of Akelaitis (2017), which suggests that grade 12 students have more developed intrapersonal skills including their self-awareness as they are experiencing identity searching and self-reflection.

Table 1

Social-emotional Learning Competencies

Indicators	Mean	SD	Verbal Interpretation
Self-awareness			
Knowing the things I am good at	2.86	.730	Highly Self-aware
Knowing to improve things I cannot do at school	2.77	.662	Highly Self-aware
Knowing when I committed a mistake on a particular thing	3.10	.712	Highly Self-aware
Knowing when I have no control over things	2.92	.756	Highly Self-aware
Being aware when I get distracted by what I feel	3.12	.767	Highly Self-aware
Knowing what I feel	2.94	.844	Highly Self-aware
Being aware of the things that make me feel better	3.24	.837	Highly Self-aware
Being aware of how my body responds when I feel nervous	3.26	.790	Very Highly Self-aware
Being aware of when my mood influences the way I interact with others	3.12	.745	Highly Self-aware
Being aware of the things that make me calm	3.13	.772	Highly Self-aware
Overall	**3.05**	**.761**	**Highly Self-aware**
Self-management			
Completing a task even when I am frustrated	2.27	.877	Lowly Self-managed
Trying to be patient for the things I am excited about	2.77	.724	Highly Self-managed
Being calm even when I am stressed	2.27	.877	Lowly Self-managed
Doing the things even if I am not interested	2.33	.809	Lowly Self-managed
Completing a task that I consider difficult	2.47	.738	Lowly Self-managed
Setting goals I want to achieve	3.14	.860	Highly Self-managed
Achieving the goals I set for myself	2.83	.791	Highly Self-managed
Planning out the actions needed to achieve my goals	2.93	.763	Highly Self-managed
Working on my school works even if I don't like it	2.63	.783	Highly Self-managed
Being ready for an upcoming test	2.59	.672	Highly Self-managed
Doing my home works even they are hard	2.77	.712	Highly Self-managed
Planning my project ahead of time so I can pass it on schedule	3.00	.766	Highly Self-managed
Completing my school works even without reminders	2.88	.811	Highly Self-managed
Maintaining concentration in class despite distractions	2.38	.808	Lowly Self-managed
Overall	**2.66**	**0.785**	**Highly Self-managed**

Indicators	Mean	SD	Verbal Interpretation
Social Awareness			
Learning from others who hold opposing views to myself	2.96	.621	Highly Socially Aware
Being aware of the feelings of other people by their facial expressions	3.08	.779	Highly Socially Aware
Knowing when a classmate is in need of help	2.99	.676	Highly Socially Aware
Knowing how to seek assistance when I'm having problems with a classmate	2.46	.846	Lowly Socially Aware
Being aware of how my actions affect my classmates	2.95	.753	Highly Socially Aware
Overall	**2.89**	**0.735**	**Highly Socially Aware**
Relationship Skills			
Respecting my classmate's point of view during an argument	3.46	.534	Very Highly Skilled
Sharing a bond with my classmates	2.85	.906	Highly Skilled
Expressing what I feel with other people	2.42	.958	Lowly Skilled
Seeking advice from an adult when I have school problems	2.32	.972	Lowly Skilled
Being open to talk even with people I do not hang out with	2.15	.952	Lowly Skilled
Having good relationships with my teachers	2.98	.765	Highly Skilled
Overall	**2.70**	**0.848**	**Highly Skilled**
Responsible Decision-Making			
Thinking about the possible consequences of an action before deciding	3.21	.705	Highly Responsible
Knowing what is right from wrong	3.39	.615	Very Highly Responsible
Having multiple solutions to a problem	2.82	.750	Highly Responsible
Refusing an offer of a classmate who wants to break rules	3.18	.677	Highly Responsible
Assisting to make the school a better place	3.05	.600	Highly Responsible
Overall	**3.13**	**.669**	**Highly Responsible**

In relation to this, the highest average for self-awareness is in terms of identifying their body reactions when they feel nervous ($\bar{x} = 3.26$). This may be caused by the corresponding academic activity which they are about to accomplish after this study was conducted, specifically, research defense (Kjolstad et al., 2020). They wanted to accomplish the survey so that they can focus their attention on their upcoming defense. This may have lessened their nervousness since they may prepare better if they finish the questionnaire first since there will be no backlogs on their part.

The student responses for their perceived self-management competency garnered a mean of 2.66. This shows that they find it easy to manage their behaviors and emotions under different circumstances. Arguedas et al. (2016) confirms this result as high school students develop their ability to regulate their feelings in an e-learning set up. Since most of the grade 12 students are also studying through online modality, this could mean that they will also acquire emotion regulation strategies to perform better in this modality. The highest mean is in terms of setting goals they wanted to achieve ($\bar{x} = 3.14$). This exhibits that it is easy for them to identify their aims in life. Senior high school students' goal-setting behaviors are highly influenced by their hope (Ciarocchi et al., 2015). During these two critical years of their

adolescent lives, grade 12 students may experience more goal-directed thoughts about their future after high school.

In their perceived social awareness, grade 12 students gained a mean of 2.89 which signifies high social awareness. This could suggest that it is easy for understand their classmates' perspectives while being aware of their different beliefs. This asserts the findings of Booker and Dunsmore (2017) wherein they found that social competence of grade 12 students develops as they interact in constructive relations with their classmates and teachers which is why adolescent years are critical in enhancing their social skills. The highest mean fall on becoming aware of the feelings of other people through their facial expressions ($\bar{x} = 3.08$). This is due to the increased emotional awareness as facial emotion recognition develops as children age from childhood to early adulthood (Lawrence et a., 2015) which includes the age range of grade 12 students.

Moreover, the respondents' perception of their relationship skills were interpreted as high with 2.70 as mean, which is an indication that it is easy for them to create and maintain meaningful relationships with other people. As students enter upper secondary schools, they would face different social demands such as forming new relationships and joining organizations which enhances their skills in handling and nurturing interactions with other people (Booker & Dunsmore, 2017). They produced very high relationship skills in respecting their classmate's points of view when they have arguments ($\bar{x} = 3.46$). This conveys that they find it very easy to consider others' opinions during a discussion. Undergoing the new educational setup, senior high school students must communicate with one another during activities that involves small group discussions, be it in a synchronous or asynchronous activity (Lee & Martin, 2017). Since the respondents perceived this aspect as the easiest task to do, this could imply that they considered it valuable to view the opinions of their classmates as an avenue to gain knowledge (Auer-Spath & Gluck, 2019).

Lastly, the responsible decision-making competency of the respondents was perceived as high with an overall mean of 3.13 which could mean that it is easy for them to create efficient and constructive decisions in academic and non-academic contexts. One of their critical decisions that grade 12 students have made is their choice of senior high school strand. Grade 12 students may have considered factors such as their school preference, interests, socioeconomic status, and scholastic rating from previous schools before deciding their strand

(Abarro, 2016). They reported very high responsible decision-making in knowing what is right from wrong. This could imply that it is very easy for them to create moral decisions properly as this indicator presented the highest mean of 3.39. This is inclined with the findings of Goyon's and Legaspi's (2020) wherein senior high school students acquired a high level of moral reasoning. This could suggest that the respondents are aware of the consequences of their actions.

Table 2 reflects the scores of the respondents in the mathematical reasoning test in terms of analyzing. From the three problems, the respondents garnered consolidating analyzing skill having 2.48 as mean and 1.131 as standard deviation. This means that one to two errors were committed in the provided similarities and differences among the related ideas and concepts that they have noticed.

Table 2

Level of Mathematical Reasoning Skill in terms of Analyzing

Analyzing	Mean	SD	Verbal Interpretation
The Painted Cube Problem	2.67	1.075	Consolidating
The Matchstick Problem	2.43	1.177	Consolidating
Two Numbers Problem	2.36	1.141	Developing
Overall	**2.48**	**1.131**	**Consolidating**

Legend: 0.0-0.80 (Not Evident), 0.81-1.60 (Beginning), 1.61-2.40 (Developing), 2.41-3.20 (Consolidating), 3.23-4.0 (Extending)

They scored highest in the painted cube problem which shows consolidating analyzing skill with a mean of 2.67. This type of task provides avenue for various explorations of patterns that can be observed spatially, algebraically, or numerically (Jazby & Widjaja, 2019). The students are able to find patterns as they are able to spot similarities and differences among painted and unpainted cubes. They were also able to create formulas and visual representations that can be used to answer the guide question. Figure 1 shows Student 4's work in this problem.

It can be observed that she has presented a spatial representation. However, two errors were in terms of number of small cubes painted on two sides (13, instead of 12) and number of cubes that is not painted at all (one cube). This level of analyzing skill with very minimal error affirms the findings of Jazby and Widjaja (2019) which state that the use of geometric and spatial strategies has a 100% accuracy rate only if done properly.

Figure 1

Reasoning of Student 4 in Problem 1 Categorized with Consolidating Analyzing Skills

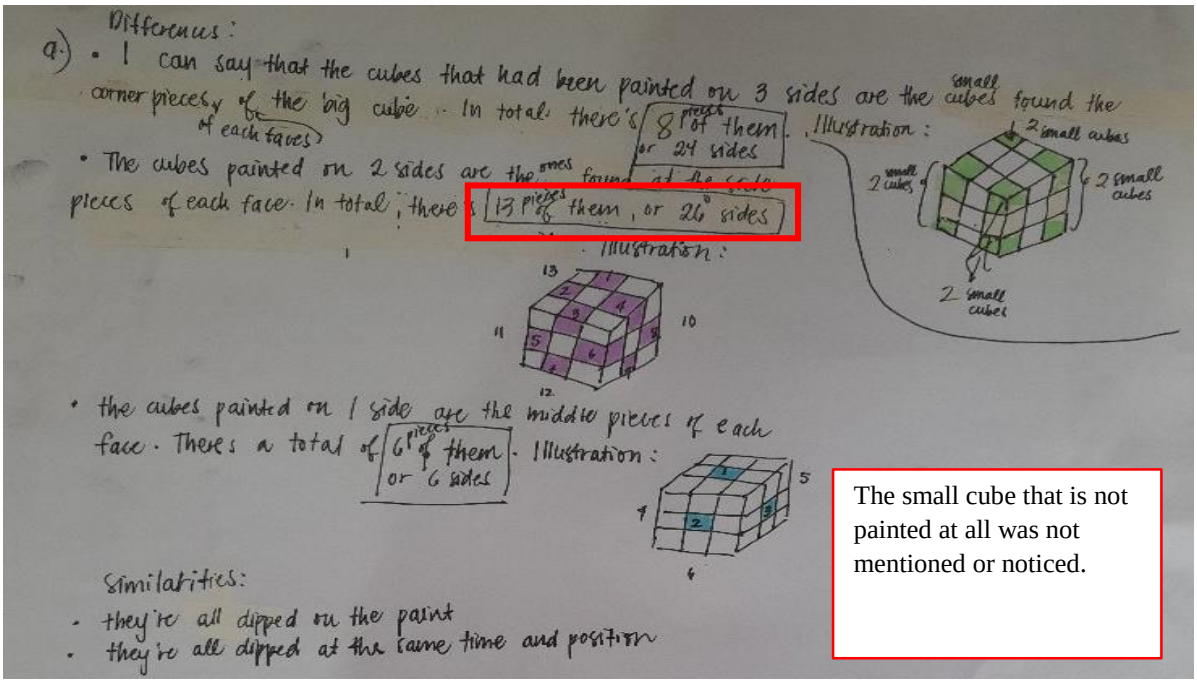


Table 3 depicts the respondents' reasoning test scores in generalizing skills. With a developing generalizing skill and a mean of 2.18, this indicates that three or more errors were made on the application of concepts from a specific case to a broader sense.

Table 3

Level of Mathematical Reasoning Skill in terms of Generalizing

Generalizing	Mean	SD	Verbal Interpretation
The Painted Cube Problem	2.33	0.983	Developing
The Matchstick Problem	2.30	1.019	Developing
Two Numbers Problem	1.86	1.166	Developing
Overall	**2.18**	**1.210**	**Developing**

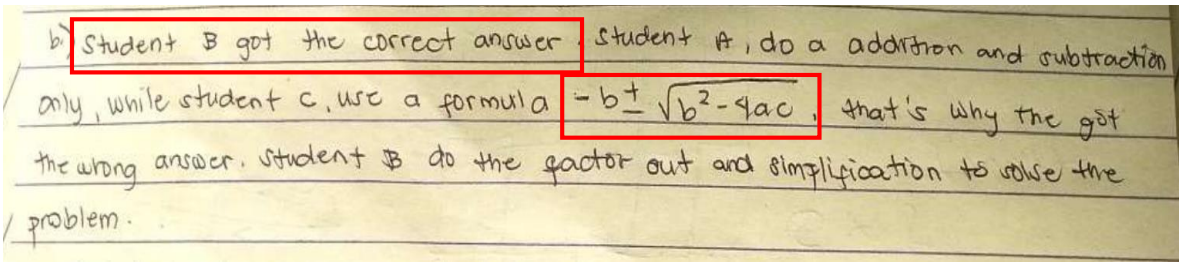
Legend: 0.0-0.80 (Not Evident), 0.81-1.60 (Beginning), 1.61-2.40 (Developing), 2.41-3.20 (Consolidating), 3.23-4.0 (Extending)

They scored the lowest in the two numbers problem with a developing generalizing skill with a mean of 1.86. This could insinuate that the respondents have difficulty in applying the algebraic concepts into a more logical problem which made them commit three or more errors. This problem assesses their knowledge in algebraic reasoning which would require them to evaluate the three given solutions' accuracy. A picture of Student 70's reasoning is

presented in Figure 2 when asked to determine which among the three provided solutions present a correct process.

Figure 2

Reasoning of Student 70 in Problem 3 Categorized with Developing Generalizing Skills



Student 70 chose the second solution as the correct answer which is incorrect because all three solutions were wrong. Also, she stated that Student B is correct because the solution used factoring method (FOIL method was used). Furthermore, she explained that the third solution was inaccurate but she had written the wrong quadratic formula. On the other hand, she mentioned a correct observation of determining the error of the first solution which involved addition and subtraction only. This level may be explained by the difficulties that senior high school students face when dealing with quadratic equations (O'Connor & Norton, 2016). Grade 12 students may be lacking in prerequisite knowledge about solving algebraic problems from junior high school mathematics.

Table 4 summarizes the justifying skills of the which fall on developing level with a mean of 2.18. This could suggest that the respondents have committed three or more errors in constructing logical arguments in an attempt to support their claims.

Table 4

Level of Mathematical Reasoning Skill in terms of Justifying

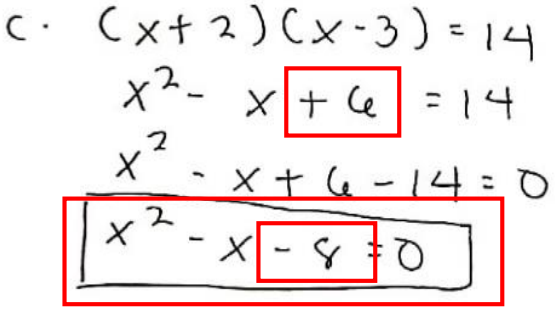
Justifying	Mean	SD	Verbal Interpretation
The Painted Cube Problem	2.31	1.078	Developing
The Matchstick Problem	2.50	1.337	Consolidating
Two Numbers Problem	1.74	1.213	Developing
Overall	**2.18**	**1.210**	**Developing**

Legend: 0.0-0.80 (Not Evident), 0.81-1.60 (Beginning), 1.61-2.40 (Developing), 2.41-3.20 (Consolidating), 3.23-4.0 (Extending)

The two numbers problem provided the lowest mean that fall under the developing justifying skills having 1.74 as mean. This could infer that they are having difficulties in providing their solutions supported by logical argument This is an algebraic problem which requires their knowledge and reasoning regarding algebraic concepts and processes. They were asked to provide their own solution for the given problem while explaining the steps that they took before arriving at an answer. The picture below manifests Student 73's reasoning for this task.

Figure 3

Reasoning of Student 73 in Problem 3 Categorized with Developing Justifying Skills



There is no justification and values of x were not obtained.

Student 73 demonstrated the use of F-O-I-L method incorrectly on simplifying the product of the two binomials. This led her to her next error on generating the standard form of the equation. Moreover, the task assigned also asks for their justification regarding the steps they made to get their answers, which she was not able to mention. Her final answer is also incorrect because the problem was referring to two numbers, not an equation. These multiple errors in her reasoning resulted in her developing level of justifying skills. Regarding this matter, most of grade 12 students were just simply stating their steps without showing their solutions. Given this, mistakes in algebraic and arithmetic skills could possibly be the reasons why the students are still struggling in this type of problem (Didis & Erbas, 2015).

Table 5 indicates the relationship between some of the perceived SELC and MRS of the respondents in varying degrees. In particular, MRS are significantly correlated to self-awareness, social-awareness and responsible decision-making. The positive weak correlation observed indicates that there is a direct relationship between social-emotional learning competencies and mathematical reasoning skills.

Table 5

Relationship Between the Perceived Social-Emotional Learning Competencies and the Level of Mathematical Reasoning Skills

	Analyzing	Generalizing	Justifying
Self-awareness	0.244**	0.190*	0.197*
Self-management	0.166	0.155	0.109
Social awareness	0.251**	0.224*	0.178
Relationship Skills	0.169	0.158	0.11
Responsible Decision-making	0.294**	0.268**	0.222*

***. Correlation is significant at the 0.01 level (2-tailed).*

**. Correlation is significant at the 0.05 level (2-tailed).*

Results have shown that the self-awareness competency is significantly correlated with analyzing; generalizing; and justifying. This affirms the study of Anggoro et al. (2021) stating that high level of self-awareness would affect students' confidence in choosing a strategy in solving open-ended. It will also help them communicate their thoughts better because they know that these reasoning tasks must have an answer which can be solved accordingly.

Meanwhile, the social awareness competency has also a significant correlation with the reasoning skills except justifying. It has positive weak correlation with analyzing and generalizing skills which highlights the role of social skills and interaction of the students when learning mathematics. Luong et al. (2021) suggest that social contexts inside the classroom help build mathematical knowledge and understanding. Interpersonal relationships could also develop students' ability to articulate their thoughts with one another. Furthermore, the relationship between social awareness and justifying skills is not significant and may be explained by the results of the survey since among all the three SELC that have significant correlation with MRS, social awareness received the lowest mean and a low interpretation in one of its indicators.

Finally, the respondents' analyzing, generalizing, and justifying skills were all significantly correlated with their responsible decision-making competency. This establishes a direct relationship between the ability to reason and create constructive choices under different situations. It can be observed that the correlation coefficients of responsible decision-making received the highest values among the five SELC. This may have occurred because mathematical reasoning influences the decision-making skills of students under risk conditions

(Pertl et al., 2017). Grade 12 students came up with different methods of approaching the given problems including drawing visual representations, generating formulas, doing trial-and-error, and manipulating algebraic expressions. Deciding on what strategy to use to finish the tasks within the time limit requires them to consider the type of problem, the appropriateness of method, and given information. Their choice would be a result of weighing options which is an indication of responsible decision-making.

Table 6

Moderating Effect of Strand on the Relationship between Social-Emotional Learning Competencies and the Level of Mathematical Reasoning Skills

Model	coeff	se	t	P	LLCI	ULCI
Constant	1.6536	0.9523	1.7363	0.0853	-0.2339	3.5411
Social-Emotional Learning Competencies	-0.6396	0.3264	-1.9598	0.0526	-1.2865	0.0072
Strand	-0.5578	0.6474	-0.8617	0.3908	-1.8409	0.7253
Int_1	0.7589	0.2214	3.4283	0.0009	0.3202	1.1977

Model Summary						
R	R-sq	MSE	F	df1	df2	p
0.8958	0.8025	0.1853	147.6171	3.0000	109.0000	0.0000

To determine whether the correlation between SELC and the MRS depends on the grade 12 students' respective strands, a multiple regression model was utilized. After centering between SELC and the MRS and computing their interaction term (Aiken & West, 1991), the variables were tested into the simultaneous regression model which have shown that their interaction was significant, indicating that the effect of SELC on MRS depended on the strand that the students enrolled in. Together, the variables accounted for approximately 80% of the variance in MR skills.

Simple slopes for the association between SELC and MRS were tested for STEM and non-STEM students. Each of the simple slope tests revealed a significant positive association between SELC and MRS for STEM students only. Figure 4 plots the simple slopes for the mentioned interaction.

Figure 4

Results of Slope Test for the Relationship Between SELC and MR for STEM and non-STEM students

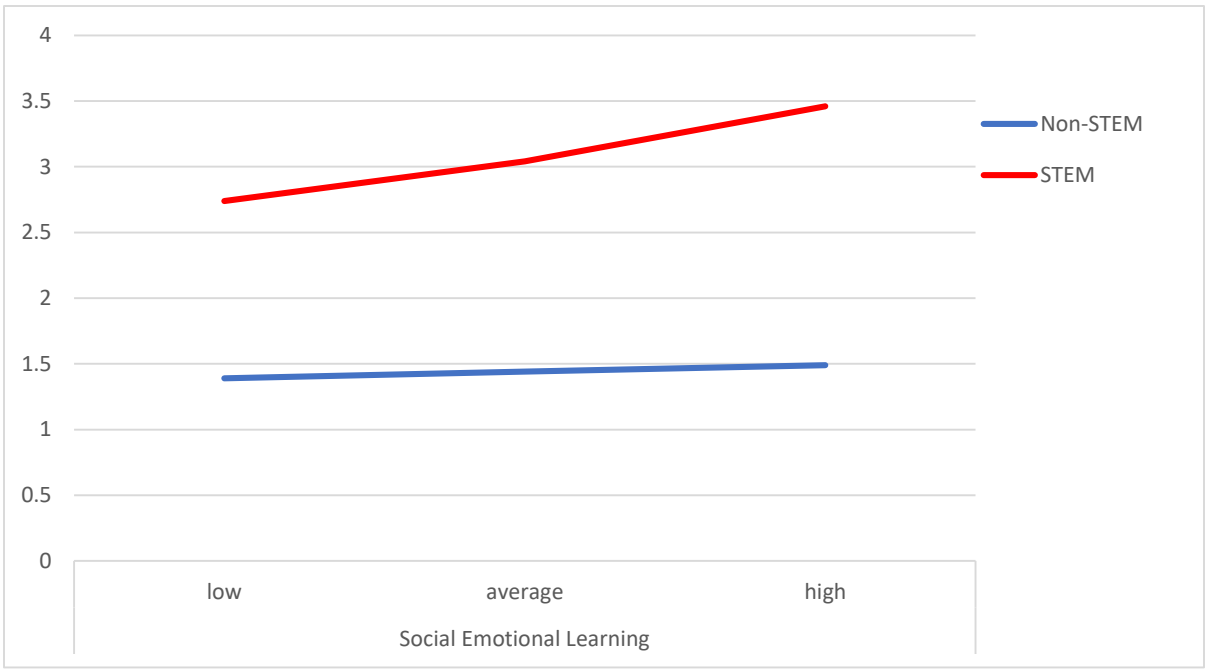


Figure 4 portrays that the increasing slope of the relationship between the two variables demonstrates a positive moderating effect of the strand on STEM students. These findings correspond with the result of the study of MacCann et al. (2020) where the ability to perceive, manage, and understand emotions were found to be a predictor of academic performance. They have also found significant moderators of this correlation in subjects (mathematics/sciences and humanities) that the respondents were taking. Senior high school strands could be distinguished by the differences of courses taken. STEM students take subjects that are more inclined with developing critical thinking, scientific skills, and problem-solving within science, technology, engineering, and mathematics courses while those enrolled in non-STEM strands are more likely to be aligned with arts, humanities, and the social sciences (Tupas & Matsuura, 2019). Having more mathematically-inclined subjects, STEM students need to acquire emotion regulation strategies in order to perform better in their strand (Kahl et al., 2021). These differences in learning contents may affect their educational outcomes. This could explain why strand plays a moderating role as to why SELC are associated with MRS.

Additionally, Cerbito (2020) also found out that senior high school students' affective states like enjoyment and motivation towards mathematics are positively correlated with their

proficiency in the subject. He dealt with significant differences in their attitudes and test scores demonstrated by students when they are grouped into their strands where STEM was found to have the highest mean. These differences of affective mathematics engagement could explain the differences in academic performance since STEM and non-STEM students have reported significantly different emotions and value regarding mathematics (Lee et al., 2019).

Furthermore, Bene et al. (2021) found that students enrolled in STEM-related fields have demonstrated high self-regulation strategies while studying. Self-regulation, a closely-related concept to the self-management competency, is found to be a predictor of the students' grade. Other SEL-related concepts like effort and persistence were also linked with successful mastery of goals and achievement in STEM-related subjects such as mathematics (Murphy et al., 2019). This may establish a connection between affective constructs and STEM education. Integrating SEL in STEM classrooms promote student engagement and classroom success (Ingram et al., 2021). Given this, the strands where the grade 12 students enrolled in could have played a role between the relationship between SELC and MRS.

5. Conclusion

The result of this study suggests that the grade 12 students has high perception of their social-emotional learning competencies in all of its components. Meanwhile, their mean scores in terms of mathematical reasoning skill fall on the consolidating level of analyzing skill, and developing level on aspects of generalizing and justifying. Results also manifest that there is a significant relationship between social-emotional learning competencies and mathematical reasoning skills except for self-management and relationship skills. Thus, teachers may consider implementing teaching strategies that could develop these soft skills and reasoning skills in and beyond the classroom context. Furthermore, it can also be gleaned from the study that the strand moderates the relationship between SELC and MRS for STEM students only. With that, future researchers may also consider using a larger sample from college students in order to determine the extent of the moderating role of STEM courses on the association between the two variables. Since the study was conducted through online set-up due to the pandemic, it is also recommended to conduct the study through face-to-face interactions. Finally, studying other potential moderating variables related to this field of study is also suggested.

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