

Research Article

Social-Emotional Profiles and Fluctuations in Mathematic Achievement: A Multiple Discriminant Analysis of Elementary School Students

Tia Rahmawati

Institut Prima Bangsa, Indonesia

tiarahmawati491@gmail.com

Lulu Salsabila

Institut Prima Bangsa, Indonesia

salsabilalulu111@gmail.com

Naasywa Aurel Ardellysa

Institut Prima Bangsa, Indonesia

ardellysa3805@gmail.com

Muhammad Kholil Anwar

Institut Pertanian Bogor, Indonesia

akholianwar@gmail.com

Abstract: Students' social-emotional competencies may influence academic achievement, yet it remains unclear whether these competencies differentiate students according to changes in mathematics report-card scores. This study described and compared elementary school students' social-emotional profiles, including self-control, social anxiety, and relationship skills, across groups with increased, stable, and decreased mathematics scores. It also identified the dimensions that contributed most strongly to group differentiation. A quantitative, comparative, cross-sectional design was employed. The sample comprised 313 students in Grades 4–6 from five public elementary schools, selected through purposive-convenience sampling. Data were collected using an adapted Social and Emotional Learning Competency Scale and official report-card records. Students were classified according to changes in mathematics scores across two consecutive semesters: increased ($n = 80$), stable ($n = 159$), and decreased ($n = 74$). Multiple Discriminant Analysis was conducted using IBM SPSS 25. The discriminant functions formed from the three social-emotional dimensions were not statistically significant, $\chi^2(6) = 6.772$, $p = .342$; therefore, the hypothesis was not supported. Nevertheless, self-control showed the strongest correlation with Function 1 ($r = .878$), and the group centroids indicated that higher self-control was more characteristic of students whose scores increased. These findings suggest that internal social-emotional competencies alone are insufficient to explain changes in mathematics achievement. Such changes are likely multidimensional and influenced by interpersonal, instructional, and contextual factors. This study provides preliminary evidence regarding the discriminative capacity of social-emotional competencies in explaining mathematics score changes among Indonesian elementary school students.

Keywords: discriminant analysis, mathematics achievement, self-control, social anxiety, social-emotional learning.

Corresponding Author:

Tia Rahmawati

tiarahmawati491@gmail.com

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INTRODUCTION

Social-emotional development is essential for the effectiveness of student learning and interaction. Social and Emotional Learning (SEL) is increasingly recognized as an essential component in educational development because it encompasses students' ability to manage emotions, build social relationships, and make responsible decisions (Sert & Arikan, 2025). SEL programs have a positive impact on students' social-emotional skills, attitudes, prosocial behaviors and the reduction of behavioral problems in school, as consistently shown by various studies (Molyneux & Diamond, 2025). The differences in SEL competencies among students are reflected in how they navigate the dynamics of learning in schools (Widyaningrum et al., 2026). Social-emotional competence is positively related to students' mathematical performance and achievement, thus contributing to variations in students' math report card scores (M. Ogoy & Comahig, 2025).

The development of elementary school students' math skills is dynamic and does not always follow the same pattern for every individual. Some students show consistent abilities, while others show slower progress or experience changes in achievement over time. Achievement differences that arise from the beginning of elementary school can develop into persistent gaps in later grades if not understood correctly (Gunderson et al., 2018). The development of students' mathematical abilities follows a varied growth trajectory, which results in variations in achievement (Dumas et al., 2019). This variation in report card scores between semesters is embedded in a broader academic growth trajectory and latent growth dynamics that reflect a systematic heterogeneity of development rather than a random exam variable (Fu et al., 2016).

Previous research has examined these relationships separately. Self-control plays a key role in increasing learning engagement through the mediation of resilience and positive emotions (Yang et al., 2024). Primary school students' self-control was associated with better quality teacher relationships and contributed to lower levels of conflict with teachers (Hajovsky et al., 2023). Teacher support felt by students affects mathematics anxiety through the mediating effect of teacher-student relationships and mathematical self-efficacy (Wang et al., 2024). The quality of peer relationships plays an important role in supporting the social development of elementary school students and is associated with the process of student adjustment in the school environment (Lee & Ha, 2023).

However, these studies generally use a correlational or regression approach that measures relationships between variables, rather than the ability to discriminate between groups. No studies have specifically used Multiple Discriminant Analysis to test the discriminative power

of the internal SEL dimension based on fluctuations in report card scores between semesters, a much more stringent approach because it requires clear boundaries of decisions between groups. This distinction is methodologically important although previous studies have shown that SEL dimensions are associated with learning outcomes, they have not tested whether these dimensions are able to actively differentiate i.e. classify students appropriately into different groups of achievement fluctuations. The study fills in that gap by shifting the analytical question from "does SEL relate to achievement variation?" to "can SEL dimensions differentiate student membership groups?", a question that has immediate diagnostic and practical value for early identification. The role of students' internal capacity through the SEL dimension in the variation in the pattern of fluctuations in mathematics report card scores as reflected in the difference in grades between semesters, especially in the Indonesian context, has not been empirically explored extensively (Gnas et al., 2024).

Previous research has shown that self-control, social anxiety, and relationship skills are linked to aspects of student development. These studies generally examine each dimension separately, linking it to specific factors in the learning process. Research identifying differences in self-control, social anxiety, and relationship skills among elementary school students based on fluctuating patterns in math report card scores is limited. This limitation is important to overcome because understanding the emotional characteristics of groups of students with different report card score patterns can help teachers comprehensively understand students' needs.

This study is expected to fill in the existing research gap through empirical mapping of differences in self-control profiles, social anxiety, and relationship skills among elementary school students with different patterns of fluctuation in math report card scores. The contribution of this study lies in the identification of the social-emotional characteristics of students based on groups with increased, stable, and decreasing report card scores. Conceptually, the study also offers an alternative framework: instead of assuming that SEL directly determines fluctuations in achievement, the capacity of internal SEL can serve as a supporting foundation whose influence is expressed indirectly, through mediation mechanisms such as learning engagement, academic motivation, self-efficacy and teacher relationships (Yang et al., 2024).

This study aimed to describe and compare the social-emotional profiles of elementary school students that included the dimensions of self-control, social anxiety, and relationship skills by group with different patterns of fluctuations in math report scores (increasing, stable, and decreasing), as well as to identify the social-emotional dimensions that contributed most to differentiating student membership in these three groups. In line with these goals, this study proposes two main hypotheses.

H1: There are significant differences in social-emotional profiles among students in the increasing, stable, and decreasing groups, as reflected in the linear discriminant function formed from a combination of the dimensions of self-control, social anxiety, and relationship skills.

H2: The self-control dimension is the variable with the highest discriminatory contribution compared to the social anxiety and relationship skills dimensions in differentiating group membership based on fluctuations in math report card scores.

THEORETICAL FRAMEWORK

Social and Emotional Learning (SEL) is the process of developing an individual's ability to understand and manage emotions, set positive goals, and make responsible decisions (CASEL, 2020). Theoretically, the SEL framework developed by CASEL identifies five interrelated core competencies: self-awareness, self-management, social awareness, relationship skills and decision-making. SEL has become an important element in modern education that directly affects the effectiveness of student interaction and learning outcomes (Sert & Arıkan, 2025). Within this framework, the dimension of self-management is very important and is operationalized through self-control. Self-control is the ability of individuals to modify internal responses to meet certain standards (Tangney et al., 2004).

Social-Emotional Learning (SEL) emphasizes skills such as empathy, cooperation, emotion management, and conflict resolution, which are critical to addressing academic and social challenges, as well as improving learning outcomes (Asdhar & Yoenanto, 2024). Social-emotional competencies not only play a role in social interaction but also help students adapt to the school environment and cope with situations that require self-control and the ability to collaborate with others (Cipriano et al., 2023). The development of social-emotional competencies is an important component in supporting students' holistic development.

Self-Control

Self-control represents the various self-regulatory abilities possessed by each individual (King & Gaerlan, 2014). Self-control plays an important role in the phase of action where individuals consciously make changes within themselves to achieve the goals and standards of targeted competencies. Empirically, high levels of self-control have been shown to produce a variety of positive effects in schools, such as superior academic achievement, harmonious social relationships, and greater psychological maturity among students (Moffitt et al., 2011). During elementary school, self-control is an important skill because it helps students obey rules, complete tasks and interact positively with their social environment. Individuals with good self-control tend to be better able to consider the consequences of their actions and adapt their behavior to the demands of the situation at hand (King & Gaerlan, 2014). Self-control is part of social and emotional competencies that support an individual's ability to manage behavior and form adaptive social relationships (Duckworth et al., 2007).

Social Anxiety

Social anxiety In children of primary school age are characterized by a persistent emotional fear of appearance situations in which they may be negatively evaluated by their school environment (Baartmans et al., 2020). According to Baartmans et al., (2020) Cognitively, children who experience this anxiety have biased and erroneous interpretations of their peers' responses, which triggers negative thoughts about their social acceptance in the classroom. The high level of social anxiety among elementary school students has the potential to disrupt the stability of mathematics report card scores.

Students who experience social anxiety tend to avoid active participation in class, are reluctant to ask questions when faced with difficulties for fear of being the center of attention, and are anxious about social judgments from those around them (Cordier et al., 2021). This psychological barrier causes students' minds to shift inward towards negative self-reflection, making it easy for them to lose focus during assessments or the learning process (Leigh et al., 2021). As a result of this limited accumulation and participation, their understanding of the material becomes incomplete, leading to fluctuations in performance.

Social Skills

From the perspective of social construction theory, the learning process is not a one-way transmission of information, but rather a reconstruction of meaning achieved through interaction and collaboration in the social network of the classroom (Li et al., 2026). The quality of relational skills during the elementary school years has instrumental and affective values that act as strong predictors of students' academic achievement (Țepordei et al., 2023). Through these supportive interactions, children do not feel anxious when faced with complex math problems because they can help each other in the study group.

Relational skills develop through students' interactions with peers, teachers, and the school environment. These skills include the ability to communicate effectively and collaborate (CASEL, 2020). Students with strong relational skills tend to have an easier time getting social support, participating in group activities and adapting to the school environment (Lee & Ha, 2023). Conversely, poor relational skills can inhibit social interaction and reduce students' chances of receiving support from those around them. Relational skills are important to be researched in understanding the characteristics of students in different groups of math report cards.

Mathematical Fluctuations

Students' mathematical achievement does not develop uniformly along a straight line, but rather forms a different growth trajectory between individuals (Mok et al., 2015). The growth pattern of mathematics achievement in elementary school children is proven to be non-linear and shows a high level of academic heterogeneity from the beginning of the year (Shanley, 2016). These trajectories differences confirm that the variation in student achievement is not a mere random mistake, but a meaningful developmental phenomenon that is empirically strongly influenced by the characteristics of social adjustment of student behavior since late childhood (Fu et al., 2016).

Report card scores are a valid indicator of academic development and reflect the level of mastery of student learning materials officially (Allen, 2005). Changes in math report card scores in the span of two consecutive semesters reflect real changes in the status of student learning achievements, not just random measurement variations. These characteristics of short-term performance changes are consistent with longitudinal findings that the growth of mathematical achievement is nonlinear and varies over time (Shanley, 2016).

METHODS

Research Design

This study uses a quantitative approach with design Comparative cross-sectional to compare the social-emotional competency profiles of students in three groups of naturally formed achievement fluctuations from report card data. Independent variables are three-dimensional Social-Emotional Learning (SEL): Self-Control, Social anxiety, and Relationship Skills, While the dependent variable is membership in the group of fluctuations in mathematical achievement: increasing, stable, and decreasing. The analysis technique used was Multiple Discriminant Analysis (MDA) to test whether the linear combination of SEL variables significantly separated students into three groups as a single multidimensional profile. The MDA method has a methodological advantage in establishing maximum classification limits among these mutually exclusive groups of categories based on a combination of simultaneous continuous predictor profiles. Discriminant analysis is able to assess the discriminative power of SEL dimensions simultaneously in a single discriminant

function, in contrast to standard linear regression or logistics that test the contribution of variables partially (Gnas et al., 2024). The threshold for structural correlation established as a measure of meaningful contribution is ≥ 0.60 (Sherry, 2006). Although multinomial logistic regression can also be used for classification into more than two groups, MDA was chosen because of its ability to generate a single discriminant function that summarizes the relative contribution of each dimension of the SEL simultaneously, making it more efficient to identify the multidimensional profiles that differentiate the three groups (Sherry, 2006).

Sample

The study population consisted of all students in grades four, five and six of the selected elementary schools, because at that grade level students were able to fill out social-emotional questionnaires accurately and independently (Riley, 2004). Sampling used a convenience-oriented sampling strategy: five public elementary schools were selected deliberately based on their willingness to participate, and all students who attended and met the criteria were included (Gülcan, 2018). Inclusion criteria include: (a) being actively enrolled in grades 4–6, (b) having a complete math report card for two consecutive semesters, and (c) willing to fill out a questionnaire voluntarily. The final sample consisted of $N = 313$ students. (156 male students, 49.8%; 157 female students, 50.2%; mean age 11 years). Students were divided into three groups based on the difference between their second-semester and first-semester math report card scores: Improved Group (upper tertile; $n = 80$, 25.6%), Stable Group (middle tertile; $n = 159$, 50.8%), and the Descending Group (lower tertile; $n = 74$, 23.6%). Cut-off points are defined using the Tertile based on the actual distribution of sample data, not external assumptions (Stenseng et al., 2022).

Data Collection

Data collection was carried out through two sources: social and emotional learning competency scale questionnaires and official school report card records. The questionnaire instruments we use are adapted from (Coelho et al., 2016) and modified by (Gülcan, 2018) which consists of 26 items originally designed to measure five dimensions of social-emotional competence: Social Awareness (5 items), Social Isolation (5 items), Self-Control (7 items), Social Anxiety (4 items), and Relationship Skills (5 items), using a Likert scale of 1–5 with negative-sounding items reversed before analysis. The instrument demonstrated adequate reliability ($\alpha = 0.81$) and good model fit ($GFI = 0.93$; $CFI = 0.91$) in the original study (Gülcan, 2018).

Before using it for discriminant analysis, we first tested the validity and reliability of all the dimensions of the instrument using SmartPLS. The test results showed that of the initial five dimensions, only three met the validity criteria: Self-Control, Social Anxiety, and Relationship Skills; Therefore, these three dimensions are then used as predictor variables in discriminant analysis. Students fill out the questionnaire independently in the classroom under the supervision of the researcher, and the score for each subdimension is calculated only if the student answers at least 70% of the total items. Academic achievement data is obtained from official school report cards with the permission of the principal, because this data reflects cumulative academic achievement for a full semester. All data collection procedures have obtained ethical approval and written permission from the school (Coelho et al., 2016).

Data Analysis

Data analysis was carried out in stages using IBM SPSS Statistics version 25. First, descriptive statistics are calculated for each SEL dimension in all three groups. Second, the MDA

assumption is examined as follows: multicollinearity ($r < 0.70$) (Dormann et al., 2013), normality through the value of Skewness and Kurtosis, and Identification of Outliers Using boxplot (Kim, 2013). Third, the reliability of the scale was evaluated using Cronbach alpha (α), Greatest Lower Bound (GLB), and omega Raykov (ω); A ω value of 0.60 is set as the minimum acceptable threshold (McNeish, 2018). Fourth, Group Average Equivalence Test using Lambda Wilks identifies SEL variables that individually contribute significantly to differentiating between groups (Sherry, 2006). Fifth, MDA is performed, and the quality of the model is evaluated based on Lambda Wilks (Λ), Eigenvalue, canonical correlation, and classification accuracy. A structural matrix with a threshold of ≥ 0.60 is used to determine the meaningful contribution of each SEL dimension (Gnas et al., 2024), and the results are interpreted with reference to (Agung et al., 2024).

RESULT

Descriptive Statistics of SEL Dimensions by Class Fluctuation Group

Table 1 presents descriptive statistics for the three dimensions of SEL based on the group of fluctuations in the mathematics report card scores. The "up" group had the highest average for self-control ($M = 3.49$, $SD = 0.424$) compared to the "stable" group ($M = 3.32$, $SD = 0.607$) and the "down" group ($M = 3.37$, $SD = 0.517$). In the social anxiety dimension, the increased group also had the highest average ($M = 3.44$, $SD = 0.443$), while the stable group had the lowest average ($M = 3.29$, $SD = 0.596$). As for relationship skills, scores were relatively comparable between the stable group ($M = 2.54$, $SD = 0.692$) and the declining group ($M = 2.54$, $SD = 0.754$), with the improved group scoring slightly higher ($M = 2.63$, $SD = 0.658$). Overall, the differences between groups in all three dimensions appear small in terms of description.

Table 1. Descriptive Statistics of SEL Dimensions by Value Report Value Fluctuations Group

Fluctuations in report card scores		Means	Standard Deviation	Valid N value (based on list)	
				Weightless	Weighted
to top	self-control	3.4876	0.42413	80	80.000
	Social Anxiety	3.4438	0.44290	80	80.000
	Relationship skills	2.6291	0.65819	80	80.000
Stable	self-control	3.3187	0.60747	159	159.000
	Social Anxiety	3.2893	0.59636	159	159.000
	Relationship skills	2.5367	0.69245	159	159.000
Down	self-control	3.3739	0.51743	74	74.000
	Social Anxiety	3.3649	0.62646	74	74.000
	Relationship skills	2.5360	0.75410	74	74.000
Total	self-control	3.3749	0,54766	313	313.000
	Social Anxiety	3.3466	0.57076	313	313.000
	Relationship skills	2.5602	0.69800	313	313.000

Normality Test

Table 2 presents the results of the normality test using the Kolmogorov-Smirnov (KS) and Shapiro-Wilk (SW) tests. All SEL dimensions in all three groups showed a $p < 0.05$,

which indicates that the formal distribution of the data does not meet the assumption of normality. These findings are consistent with the findings of Gnas et al. (2024), who also identified critical values for tilt and curtosis at several scales. Nonetheless, linear discriminant analysis is quite robust against normality violations when the sample size is adequate; Therefore, the analysis continued.

Table 2. Normality Test Results for SEL Dimensions by Value Report Fluctuation Group

SEL Dimensions	Groups	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistics	df	Signature.	Statistics	df	Signature
Self-Control	Increase	0.214	80	0.000	0.880	80	0.000
	Stable	0.182	159	0.000	0.898	159	0.000
	Downward	0.157	74	0.000	0.907	74	0.000
Social Anxiety	Increase	0.313	80	0.000	0.829	80	0.000
	Stable	0.254	159	0.000	0.850	159	0.000
	Downward	0.234	74	0.000	0.838	74	0.000
Relationship Skills	Increase	0.139	80	0.001	0.963	80	0.021
	Stable	0.113	159	0.000	0.972	159	0.002
	Downward	0.150	74	0.000	0.961	74	0.022

Multicollinearity Test

Table 3 presents a correlation matrix among the three SEL predictor variables. All correlations between variables were below the threshold of $r < 0.70$, which was established as an indication of multicollinearity, namely self-control and social anxiety ($r = 0.393$, $p < 0.001$), self-control and relationship skills ($r = 0.305$, $p < 0.001$), and social anxiety and relationship skills ($r = 0.218$, $p < 0.001$). Thus, the assumption of being free of multicollinearity is met, and the three variables can be used together in a discriminant analysis.

Table 3. SEL Intervariable Correlation Matrix (Multicollinearity Test)

Variable	1. Self-Control	2. Social Anxiety	3. Relationship Skills
1. Self-Control	1		
2. Social Anxiety	.393**	1	
3. Relationship Skills	.305**	.218**	1

Note: ** $p < .001$ (2-tailed); $N = 313$; $r < .70$ indicates free of multicollinearity

Group Average Equivalence Test

Prior to the discriminant analysis, a group mean similarity test was performed for each variable using univariate analysis. The results in Table 4 show that none of the SEL dimensions were able to significantly differentiate between groups: self-control ($F=2.556$, $p=0.079$), social anxiety ($F=2.011$, $p=0.136$), and relationship skills ($F=0.523$, $p=0.593$). These findings provide an early indication that the discriminating power of each dimension of the SEL, when considered individually, is limited. Nevertheless, discriminant analysis is continued to evaluate the discriminating power of the linear combination of the three dimensions simultaneously, in accordance with the procedure followed by Gnas et al. (2024).

Table 4. Group Average Equivalence Test

Variable	Wilks' Lambda	F	df1	df2	Sig.
Self-control	0.984	2.556	2	310	0.079
Social Anxiety	0.987	2.011	2	310	0.136
Relationship skills	0.997	0.523	2	310	0.593

Covariance Matrix Homogeneity Test (Box's M)

Table 5 presents the results of the Box's M test which is used to evaluate the assumption of similarity of the covariance matrix between groups. The results showed Box's M = 28.496 with $F = 2.337$ ($df_1=12$, $df_2=233458,312$, $p=0.005$). Although a $p < 0.05$ formally indicates a violation of the assumption, this is a common occurrence at large sample sizes because the test is very sensitive to the number of cases. Linear discriminant analysis is known to be quite strong against moderate violations of this assumption; Therefore, the analysis continues by considering these findings as limitations that need to be noted.

Table 5. Covariance Matrix Homogeneity Test Results (Box's M)

Statistics	Value
Box M	28.496
F (Approximate)	2.337
df1	12
df2	233458.312
Significance (p)	0.005

Note: Testing of the null hypothesis of the similarity of the population covariance matrix; Significance at $p < 0.05$ is common in large samples.

Hypothesis Testing 1: Significance of Discriminant Functions

The first hypothesis states that there is a significant discriminating function of the SEL dimension that is able to differentiate student membership into three groups based on fluctuations in mathematical achievement. To test this hypothesis, the eigenvalues, canonical correlations, and Lambda Wilks tests presented in Table 6 are evaluated.

Table 6. Wilks' Eigens and Lambda Values of Discriminant Functions

Function Test	Lambda Wilks			
	Lambda Wilks	Chi-square	df	Signature.
1 to 2	0.978	6.772	6	.342
2	0.999	0.259	2	0.878

Note: Function 1 explains 96.2% of the total variance; $\chi^2(6) = 6.772$, $p=0.342$

Function 1 has an eigenvalue of 0.021 with a canonical correlation of 0.144, which explains 96.2% variance. Wilks' Lambda test yielded a value of 0.978 with $\chi^2(6)=6.772$, $p=0.342$. Because $p>0.05$, the discriminant function was not statistically significant. Thus, H1 was rejected. A linear combination of self-control, social anxiety, and relationship skills was not found to significantly differentiate student membership in three groups based on fluctuations in math achievement. These findings differ from the findings of Gnas et al. (2024), who found a significant discriminant function ($\chi^2(14) = 50.193$, $p < 0.001$) in differentiating students based on their social-emotional profiles, likely because Gnas et al. used seven more diverse dimensions of SEES and a sample that was matched using predisposition score matching.

Hypothesis Testing 2: Self-Control as the Dimension with the Highest Discriminatory Contribution

The second hypothesis predicts that self-control will be the main distinguishing factor that characterizes groups with stable achievement compared to groups with decreased grades. To test this hypothesis, the structural matrix and centroid of the group at Function 1 were examined.

Table 7. Discriminant Function Structure Matrix

	Function	
	1	2
self-control	0.878 *	0.256
Social Anxiety	0.776 *	-.425
Relationship skills	0.368	0.759 *

Note: The asterisk (*) indicates the greatest absolute correlation between each variable and any discriminant function.

Table 8. Discriminant Function in Group Centers

Fluctuations in report card scores	Function	
	1	2
Improve	0.230	0.018
Stable	-.122	0.015
Down	0.013	-0.052

Non-standardized canonical discriminant functions were evaluated on group averages.

Based on the structural matrix (Table 7), self-control had the highest correlation with Function 1 (.878), followed by social anxiety (.776), while relationship skills were more strongly correlated with Function 2 (.759). This confirms that self-control is the dimension that most clearly distinguishes between groups in Function 1. However, the centroid analysis of the group (Table 8) revealed the direction of the difference that did not match the hypothetical prediction. Function 1's centroid shows that the "up" group has the highest score (.230), the "down" group is in the middle (.013), and the "stable" group is actually at the lowest (-.122). This pattern suggests that self-control characterizes the "up" group more than the other. Thus, H2 is partially supported: self-control is proven to be the dimension with the highest discriminant correlation (.878), which confirms its position as the main discriminator. These findings also broaden the theoretical understanding that self-control is not only related to stability but more strongly characterizes active achievement growth.

Classification Accuracy

Table 9 presents the results of the classification of group members based on the discriminating function. Overall, the discriminant function was only able to correctly classify 39.6% of cases on the original data and 36.1% on the cross-validation set. These numbers were above the accuracy of the random classification (33.3% for three groups of the same size), but did not differ significantly. The pattern of misclassification suggests that most cases, particularly those in the stable (49.1%) and declining (45.9%) groups, tend to be misclassified into the ascending group, consistent with the finding that the discriminant function is not statistically significant.

Table 9. Group Membership Classification Results

Actual Group		Predicted Group Membership			Total
		Increase	Stable	Downward	
Original	Increased (n=80)	47 (58,8%)	19 (23,8%)	14 (17,5%)	80
	Stable (n=159)	78 (49,1%)	63 (39,6%)	18 (11,3%)	159
	Decreased (n=74)	34 (45,9%)	26 (35,1%)	14 (18,9%)	74
Cross-Validated	Increased (n=80)	43 (53,8%)	21 (26,3%)	16 (20,0%)	80
	Stable (n=159)	79 (49,7%)	60 (37,7%)	20 (12,6%)	159
	Decreased (n=74)	36 (48,6%)	28 (37,8%)	10 (13,5%)	74

DISCUSSION

This study aimed to test students' internal three-dimensional SEL abilities of self-control, social anxiety, and relationship skills in differentiating student membership into three groups based on fluctuations in math report card scores using Multiple Discriminant Analysis. Overall, both hypotheses proposed are not supported by data. Before interpreting these findings substantively, it is important to consider several alternative explanations. With a relatively large sample size ($N = 313$) but a very small canonical correlation (0.144) and a Lambda Wilks value close to 1 (0.978), these non-significant results most likely reflect a substantially small effect, rather than a mere limitation of statistical power (Statistical power) (Gail M. Sullivan, MD, MPH Richard Feinn, 2012).

However, there may be limitations to the validity of self-reported SEL measures (self-report) (Duckworth & Yeager, 2015), which potentially does not accurately capture variations in students' emotional capacity still needs to be considered as an interpretive limitation. Taking these things into account, these findings can be interpreted as a meaningful scientific contribution: empirically confirming that fluctuations in mathematics achievement in elementary school students are a multidimensional phenomenon that cannot be reduced only to the capacity of the students' internal SEL (Li et al., 2026). The implications of each of the findings are discussed in more depth below.

Internal SEL Dimensions Are Not Enough as the Only Differentiator

The first hypothesis is rejected: the discriminant function formed from a three-dimensional combination of SEL is insignificant ($\chi^2(6)=6.772$, $p=0.342$). These findings raise important theoretical questions as to why the SEL dimension, which has been consistently associated with academic achievement in various studies (Moffitt et al., 2011), is not able to form a significant discriminatory function in the context of this study? The answer lies in the difference between correlational relations and discriminatory power. Previous studies generally used regression or correlation to measure the extent to which one variable relates to another. However, MDA demands more than that: predictive variables must be able to form clear decision boundaries between groups. It's much tighter. The fact that self-control correlates with academic achievement (King & Gaerlan, 2014; Moffitt et al., 2011) That doesn't automatically mean that self-control can discriminately distinguish between students whose grades are increasing, stable, or decreasing.

A more basic explanation has to do with the complexity of the determinants of fluctuations in mathematics report card scores. Report card scores are the end result of long-term interaction between internal student factors (cognitive ability, motivation, self-regulation), interpersonal factors (teacher-student relationships, peer support), and contextual factors (teaching quality, consistency of assessment standards between semesters). Changes in report card scores from semester to semester not only reflect students' internal SEL capacity, but are also influenced by factors beyond the student's control, such as differences in material difficulty, teacher turnover, or changes in assessment standards (Engida & Iyasu, 2023). From this perspective, the three dimensions of SEL tested in this study serve as a necessary condition but are not sufficient to distinguish fluctuations in academic achievement.

These findings are also consistent with the argument (Cipriano et al., 2023) which states that SEL interventions are most effective when integrated into a supportive learning context, rather than stand-alone. A student's SEL competence may not be reflected in changes in

report card scores if the classroom environment does not provide space for the expression of those competencies (Moffitt et al., 2011). This explains why internal SEL alone is not enough to discriminate groups based on performance fluctuations.

Self-control is more of a hallmark of performance growth than stability

The second hypothesis predicts that self-control will be the dimension with the highest discriminant contribution compared to social anxiety and relationship skills. The findings support this position: self-control has the highest discriminant correlation in Function 1 (.878). An additional finding that enriched the analysis was the direction of the difference shown by the centroid that self-control better described the increased group (.230) compared to the stable group (-.122) and the decreasing group (.013). This directional finding can be explained theoretically. Self-control within the framework of CASEL is concerned with self-management abilities that encourage individuals to actively exert effort to achieve goals (Tangney et al., 2004). Students whose grades improve are those who actively make changes to their learning behavior—they regulate the desire to avoid studying, maintain focus, and delay short-term satisfaction. This is the most obvious expression of self-control. In contrast, students whose grades remain stable do not necessarily have higher self-control; They may simply be in a state of learning homeostasis that does not require intense self-regulatory efforts.

Yang et al., (2024) found that self-control increased learning engagement through mediation of resilience and positive emotions. This suggests that the relationship between self-control and academic achievement is indirect and mediated by intermediate variables. In this context, self-control does not directly determine whether a student's grades increase, remain stable, or decrease, but operate through a longer series of psychological processes. As a result, using self-control as a direct discriminating variable without taking into account its mediator has the potential to underestimate its discriminating power. (Al., 2018; Zhang, 2021) It also shows that self-control among elementary school students is more strongly related to the quality of teacher-student relationships than to academic achievement directly, further confirming that the influence of self-control on grade fluctuations is indirect. The theoretical explanation for this finding can be seen from two perspectives. First, from the perspective of social anxiety, research by (Baartmans et al., 2020) It shows that social anxiety in elementary school students primarily affects the perception of social acceptance by peers, rather than directly affecting academic achievement. The impact of social anxiety on math report card scores is most likely mediated by cognitive variables such as math-specific anxiety (Song et al., 2023), which differs in construction from the general social anxiety measured in this study. In other words, general social anxiety may not be sensitive enough to distinguish fluctuations in mathematical achievement specifically.

Second, from a relationship skills perspective, it was found that peer relationships affect achievement through the mediation of perseverance and teacher-student relationships. This means that the influence of relationship skills on report card scores is not a direct influence but is mediated by other variables. Meanwhile, (Li et al., 2026), using a structural equation model, found that social-emotional competence influences achievement through learning engagement and teacher-student relationships as mediators. If these mediator variables are not included in the model, the effect of relationship skills on achievement fluctuations becomes undetectable by discriminating analysis. Further, (Țepordei et al., 2023) shows that peer relationships affect achievement through the mediation of perceived academic competence, rather than directly. This explains why the skill of equal relationships between

stable and declining groups does not necessarily differentiate them in terms of value fluctuations: such relationships are too indirect to be detected by MDAs, which measure group differences directly.

Contribution of Findings: Zero Results as Scientific Evidence

Although both hypotheses are rejected, the study's findings make a substantial scientific contribution. Methodologically, this study is one of the first to apply MDA to test the discriminative power of the internal SEL dimension related to fluctuations in the mathematics report card scores of elementary school students in the Indonesian context. The use of report card scores as the basis for objective grouping is a novelty that distinguishes this study from previous research, which generally uses self-reported achievements. (M. Ogoy & Comahig, 2025; Sert & Arikan, 2025). Theoretically, these findings provide empirical evidence that a single explanatory model based solely on internal SEL is insufficient to understand fluctuations in mathematical achievement. This emphasizes the importance of an integrative model that combines internal student factors (SEL) with external factors such as the consistency of assessment standards between semesters, teaching quality, and the dynamics of changing the learning context from one class to the next. Thus, these findings open up a new research agenda: a more comprehensive structural model is needed that places SEL as a variable mediated or moderated by contextual factors, rather than as a direct discriminatory predictor.

In practical terms, these findings convey an important message for education practitioners: interventions aimed at developing students' SEL (Social and Emotional Learning) must be accompanied by improvements in the learning context, including improving the quality of teacher-student relationships and consistency of assessment standards between semesters in order to have a real impact on fluctuations in mathematical achievement (Barnes et al., 2012). Even students with high self-control may not show an increase in report card scores if contextual factors such as changes in the difficulty level of material or teacher turnover are not taken into account (Guskey, 2024) or if the classroom environment does not support the expression of their social-emotional competence (Id et al., 2022).

CONCLUSION

This study examined whether the three dimensions of internal SEL self-control, social anxiety and relationship skills could differentiate elementary school students into groups of increasing, stable, and decreasing math achievement using Multiple Discriminant Analysis. Three main findings were obtained. First, the discriminant functions formed from the three dimensions of the SEL were not statistically significant, suggesting that the internal SEL capacity alone was not sufficient to distinguish the achievement fluctuation groups. Second, self-control showed the highest discriminant contribution among the three dimensions, although its association with the group increased weaker than hypothetical. Third, these findings indicate that fluctuations in mathematical achievement are shaped by multidimensional factors, both interpersonal and contextual, rather than just emotional-internal, so further research needs to test integrative models in which SEL functions as a mediated or moderated variable rather than as a single predictor.

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