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Investigating the Differential Relationship Between the Big Five Domains of Social and Emotional Skills and Mathematics Achievement

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Abstract

The current study explores the differential relationship between social and emotional learning (SEL), based on the Big Five personality traits, and mathematics achievement among Turkish high school students. Using data from the OECD's 2019 Survey on Social and Emotional Skills (SSES), it examines how SEL dimensions predict math outcomes and how these relationships vary by gender, socioeconomic status (SES), and level of SEL evaluation in schools. Key findings reveal that open-mindedness and emotional regulation positively correlate with math achievement, while high social engagement shows a negative association. Girls' SEL skills had a stronger predictive value for math achievement than boys, and SEL had a more substantial impact on students from lower SES backgrounds. Formal SEL assessment in schools was also related to higher math scores. These results emphasize the importance of SEL programs tailored to specific demographic needs, particularly for disadvantaged students, and suggest that formal SEL assessment in schools could enhance academic outcomes.

Keywords:

Social And Emotional Learning; Mathematics Achievement; Differential Relationship; Survey on Social And Emotional Skills

Introduction

In recent years, the rapid advancement of digitalization and globalization has profoundly reshaped the educational landscape, necessitating a holistic approach to student development. Beyond the traditional focus on cognitive skills, there is a growing acknowledgment of the pivotal role that social and emotional learning (SEL) plays in equipping students with the competencies required to navigate a complex world (OECD, 2021). Social and emotional skills, defined as the consistent patterns of thoughts, feelings, and behaviors that individuals can cultivate through formal and informal learning experiences, are recognized as important determinants of socio-economic outcomes throughout one's life (OECD, 2021).

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SEL is increasingly viewed as essential to both educational and social development. The Collaborative for Academic, Social, and Emotional Learning (CASEL) describes SEL as the process through which individuals, both young and old, acquire and apply the knowledge, skills, and attitudes necessary to develop healthy identities, manage emotions, achieve personal and collective goals, empathize with others, establish and maintain supportive relationships, and make responsible decisions (CASEL, 2020). In this digitalized era, having advanced social and emotional skills plays an important role in individuals' career development (Green, 2024). Individuals with advanced social and emotional skills, including assertiveness, creativity, and perseverance, are likely to have a more significant influence on the future labor market (OECD, 2024). Thus, the growing importance of SEL is evident in global educational initiatives aimed at fostering both cognitive and social-emotional competencies, thus enabling students to tackle the challenges of modern life.

Importance of Social and Emotional Learning

In accordance with the reforms introduced in education systems, particularly since the 2000s, it is evident that the relevance of social and emotional skills that contribute to enhancing academic performance has significantly increased (Candeias et al., 2020). Also, social and emotional skills provide a range of multidimensional advantages, facilitating students' growth across different aspects of their development including academic success, individual well-being, health and profession (Kankaraš & Suarez-Alvarez, 2019; OECD, 2024). Therefore, the role of SEL in education is increasingly recognized as critical for student success, both academically and in broader life outcomes. SEL fosters the development of essential life skills, including emotional regulation, empathy, decision-making, and relationship-building, which are indispensable for navigating the complexities of modern society (Goleman, 1995). Research has demonstrated that SEL programs can significantly enhance students' academic performance, social behaviors, and emotional well-being and it is highlighted that students who participate in SEL programs not only perform better academically but also exhibit more positive social behaviors and fewer behavioral issues (Durlak et al., 2011; Taylor et al., 2017). Also, it is reported that SEL programs provide an increase in life-satisfaction, more cooperative behavior, and more self-efficacy on students (Durlak et al., 2015; Gol-Guven, 2021).

To develop more targeted and focused educational interventions, it is essential to understand the relationship between SEL and math ability for various kinds of student groups, including gender groups, students from low- and high-socioeconomic-status (SES) backgrounds and student groups whose SEL is assessed to varying degrees. Research has consistently shown that gender plays a significant differential role in the development of social and emotional skills. For instance, girls often excel in social and emotional competencies such as empathy and cooperation, which are closely linked to academic success (Poropat, 2009). However, there is also evidence suggesting that boys may benefit differently from SEL programs, with some studies indicating that boys may show greater improvements in areas such as emotional regulation and task performance when exposed to targeted SEL interventions (Taylor et al., 2017). Exploring gender differences in the relationship between SEL and mathematics achievement has the potential to provide insights into how educational strategies can be tailored to support both boys and girls effectively.

SES is another critical factor influencing academic achievement. Students from higher SES backgrounds typically have access to more resources, both at home and in school, which can enhance their academic performance. Conversely, students from lower SES backgrounds often face additional challenges that can hinder their academic success, such as limited access to educational resources, lower parental involvement, and greater exposure to stress (Sirin, 2005). The OECD (2021) has emphasized the importance of addressing these disparities through targeted educational interventions that support the development of social and emotional skills, helping to level the playing field for students from disadvantaged backgrounds. Therefore, it is necessary to investigate how SES moderates the relationship between the Big Five domains of SEL and mathematics achievement, providing insights that could inform policies aimed at reducing educational inequalities.

Furthermore, the extent to which SEL is formally evaluated within schools significantly impacts its effectiveness. Schools that actively assess and promote SEL tend to foster environments that support both social and academic growth, whereas those that do not assess may miss critical opportunities to enhance student outcomes (CASEL, 2019). The significance of systematic SEL assessment in promoting academic achievement could be highlighted by analyzing the differential relationship of SEL based on whether students' social and emotional abilities are evaluated formally, informally, or not at all.

Evaluating SEL as a Large-Scale Assessment

Since assessment is a crucial component of comprehending a construct, SEL assessment is an important component of building social and emotional skills in order to create effective teaching techniques and learning outcomes (Agliati et al., 2020). A thorough SEL assessment system should be put in place, according to researchers, educators, and politicians from different countries, in order to support

student performance and achievement. Agliati et al. (2020) state that in order to support student learning in the classroom, social and emotional competences must be evaluated, just like the other learning domains. They contend that proper evaluation practices may give students feedback on their performance, assist them in monitoring their personal growth, and advise teachers on the best teaching methods to use.

In order to assess SEL globally, OECD is conducting a study on social and emotional skills. The most extensive international study on SEL skills is conducted by the OECD, which includes data from 10 cities across 9 nations. The objective was to create and provide a conceptual framework for the Social and Emotional Skills Study, which aims to clarify the educational, family-related, and personal elements that either facilitate or hinder the development of these abilities in a variety of student populations and environments (Kankaraš & Suarez-Alvarez, 2019). The current conceptual framework of Kankaraš and Suarez-Alvarez (2019) focuses on the underlying skills of the Big Five model that are indicative of positive life effects. It incorporates the merged and integrated competences from different applicable frameworks.

Present Study

The current study examines the differential relationship between the Big Five domains of social and emotional skills-task performance, emotional regulation, engaging with others, collaboration, and open-mindedness-and mathematics achievement. The study utilizes data from the OECD's 2019 Survey on Social and Emotional Skills (SSES) in Turkey, with a specific focus on 9th to 11th-grade students in Istanbul. The OECD's framework for social and emotional skills, which integrates various applied frameworks, underscores the critical role these skills play in shaping educational outcomes and overall life success (Kankaraš & Suarez-Alvarez, 2019).

In Turkey, the integration of SEL into the educational system has been less comprehensive compared to other countries, particularly concerning formal evaluation and curriculum integration. This study aims to bridge this gap by providing empirical evidence on how SEL, as conceptualized through the Big Five domains, is related to academic achievement in mathematics. By doing so, it offers valuable insights that could guide the development of more effective SEL programs in Turkish schools, potentially leading to improved educational outcomes for students across various demographics.

The current study is distinguished by its focus on the Turkish educational context, applying the Big Five model of social and emotional skills to predict mathematics achievement. While previous research has extensively explored the impact of SEL programs on general academic performance, there is a notable paucity of studies examining how these relationships may vary across different demographic and socioeconomic groups within Turkey. For instance, the meta-analysis conducted by Durlak et al. (2011) revealed that students participating in SEL programs exhibited enhanced academic performance, improved social behaviors, and reduced emotional distress. However, these studies have not sufficiently explored whether these benefits are consistent across gender, socioeconomic status (SES), or the level of SEL evaluation within schools. Therefore, the current study seeks to address these gaps by not only applying the Big Five domains to assess their relationship with mathematics achievement but also by investigating how this relationship may differ based on gender, SES, and the extent to which SEL is formally evaluated within schools. As the current study is one of the first studies conducted in Turkey in this area, it offers valuable insights that could inform educational policy and practice in the country. Additionally, the findings may contribute to the broader international discourse on the role of social and emotional skills in education, particularly in contexts where cultural and socioeconomic factors significantly influence educational outcomes.

The study is guided by the following research questions:

1. To what extent do the Big Five domains of SEL—task performance, emotional regulation, engaging with others, collaboration, and open-mindedness—predict mathematics achievement among high school students?

2. Is there a differential relationship between the SEL skills and mathematics achievement for gender groups and SES groups?

3. To what extent evaluation of social and emotional skills at school moderated the relationship between SEL and mathematics achievement?

Method

Participants

The current study used a dataset collected for the OECD's Survey on Social and Emotional Skills (SESS) study (OECD, 2021). The participants of the OECD's SESS study were 10- and 15-year-old students from 10 cities: Bogota, Colombia; Daegu, Korea; Helsinki, Finland; Houston, Texas, United States; Istanbul, Turkey; Manizales, Colombia; Moscow, Russian Federation; Ottawa, Ontario, Canada; Sintra, Portugal; and Suzhou, People's Republic of China. The OECD used a two-stage stratified random sampling method to choose the participants: first, schools were chosen, and then students were chosen from those schools.

In the current study 15-year-old students' data was used as older students could provide more consistent responses to self-assessment scales (Poropat, 2009; Rice and Pasupathi, 2010). Thus, the sample for this study comprised of 3168 students from 80 different high schools located in Istanbul.

The Instruments

The instruments and information listed below were used to produce the variables of the current study: a SEL survey, math achievement grades provided by schools, a survey assessing students' socioeconomic status, and a survey requesting information on how social and emotional skills were assessed in the classroom. The details are provided below.

The survey for SES

One of the instruments of the current study was the social-emotional skills survey of SSES 2019 study conducted by OECD. Based on the "Big Five Model" (John, Naumann, & Soto, 2008), the SSES theoretical framework was developed to assess the social and emotional competencies of youth (Chernyshenko et al., 2018). Collaboration, emotional regulation, engaging with others, open-mindedness and task performance, each with three subdimensions, were the five main domains of the SSES 2019 study.

In the survey the collaboration domain was defined as a combination of the abilities of empathy, trust, and cooperation that empathy is the ability of understanding and caring the other people and their well-beings; trust is the ability to assume that people generally act with good intentions and to forgive the wrong behaviors; co-operation is the ability to live together peacefully with others and respects the interdependence of all individuals (Kankaraš & Suarez-Alvarez, 2019). A sample item for the collaboration domain was "I am ready to help anybody."

Emotional regulation domain was defined as emotional stability with the combination of the skills; stress resilience, optimism, and emotional control that stress resilience is the ability to modulate anxiety effectively and solve problems calmly; optimism is the ability to have hopes for life positively and optimistically; emotional control is the ability to apply effective methods for controlling anger, aggression, and irritation in case of frustration (Kankaraš & Suarez-Alvarez, 2019). A sample item for the emotional regulation domain was "I keep my emotions under control".

Engaging with others domain was defined as extraversion with the combination of the skills; sociability, assertiveness, and energy that sociability is the ability to initiate and sustain social interactions with people; assertiveness is the ability to articulate thoughts, needs, and emotions with confidence and create social impact; energy is the ability to engage daily life with enthusiasm, energy, and spontaneity (Kankaraš & Suarez-Alvarez, 2019). A sample item for the engaging with others domain was "I like to spend my free time with others".

Open-mindedness domain was defined as openness to experience with the combination of the skills; curiosity, tolerance, and creativity that curiosity is the ability to have passion for learning, comprehension, and intellectual investigation; tolerance is the ability to be open to different perspectives and to appreciate the diverse values and cultures; creativity is the ability to generate innovative ways by means of vision, explorations, and learning from failure (Kankaraš & Suarez-Alvarez, 2019). A sample item for the open-mindedness domain was "I am willing to be friends with people from other cultures".

Task performance domain was defined as conscientiousness with the combination of the skills; responsibility, self-control, and persistence that responsibility is the ability to fulfill the commitments, as well as being punctual and trustworthy; self-control is the ability to resist disturbances and spontaneous desires and concentrate on the present task to reach a particular objective; persistence is the ability to persevere until a task or activity is completed (Kankaraš & Suarez-Alvarez, 2019). A sample item for the task performance domain was "I finish things despite difficulties in the way".

Assessing mathematics achievement

The current study used the standardized school grade for math classes taken in school as a proxy for mathematical achievement. Since participating cities have distinct grading systems, the OECD converted all grades to a scale of 1 to 50 (OECD, 2021).

Socioeconomic status index

The socioeconomic status (SES) index is derived from information about the household possessions (HOMEPOS), parental employment status as determined by the international socio-economic index of occupational status (ISEI), and parental education as determined by the International Standard Classification of Education scheme (ISCED). Open-ended questions were included in the surveys for parents and students to gather data on home possessions, occupation, and education. The authors of the current study divided the subjects into three equal-number groups to generate three categories based on socioeconomic status.

Evaluation of social and emotional skills in schools

Evaluations of social and emotional learning in the schools were another variable to take into account. By answering the following question, teachers disclosed information about whether social and emotional competencies were assessed in their institutions. "Is students' achievement in social and emotional skills evaluated in your school? No, we don't evaluate these skills; Yes, using informal evaluation (e.g. oral reports to students or parents, etc.); Yes, using formal evaluation (e.g. written reports, grades, etc.)" (OECD, 2021, p.12).

Data Analysis

First, the proposed model's fit was assessed in the current study using confirmatory factor analysis (CFA) (See Figure1). The main goal of confirmatory factor analysis is to statistically evaluate the significance of a hypothesized factor model, in other words, whether the sample data support hypothesized model (Schumacker & Lomax, 2004). Then, utilizing the main SEL domains, mathematical achievement was predicted using structural equation modeling (SEM). Lastly, SEM analyses were repeated for gender groups, SES groups and SEL evaluation groups to evaluate differential relationships. CFA and SEM analyses were performed using Mplus 7.4 to address the research questions of the current study. Sample weights can be taken into account by Mplus during the analysis process (Muthén & Muthén, 2012).

In CFA, 15 subdimensions of SEL were hypothesized to be related to five main domains (Collaboration, Emotional regulation, Engaging with others, Open mindedness and Task performance) as proposed in the Big Five Model. Goodness of fit indices show whether the data and the proposed model are similar. According to these goodness of fit indices, a good fit is indicated by a Root Mean Square Error of Approximation (RMSEA) value of 0.06 or less, and an acceptable fit is indicated by a value of 0.10 or less. A good fit is indicated by a Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) of 0.95 or higher, while an acceptable fit is indicated by a value of 0.90 or higher (Byrne, 1998; Ullman, 2001). After evaluating the fit of the measurement model, mathematical achievement was predicted by these five main domains of SEL using SEM. The analyses were repeated for the gender, SES, and SEL evaluation groups in order to assess whether the findings differ for various groups or not. MLR estimation method was used in CFA and SEM analysis as the achievement and SEL domains were created as continuous variables. The assumptions of normality, linearity and multicollinearity were evaluated, and it was concluded that none of the assumptions were violated.

Results

The major goal of the current study is to investigate the differential relationship between the social and emotional skills and mathematics achievement of students for various groups such as gender groups, SES groups and SEL evaluation groups. The following section contains the preliminary and comprehensive analyses for the research questions.

Descriptive Statistics

The descriptive statistics of mathematics achievement and social and emotional skill subdimensions were provided to indicate the key characteristics of the data (See Table 1). For the grouping variables, the frequencies are provided in Table 2.

Confirmatory Factor Analysis of SEL Measurement Model

The confirmatory factor analysis results for three competing models are presented in Table 3. In Model 1, 15 subdimensions were hypothesized to be related to

Figure 1.
Measurement model of the study

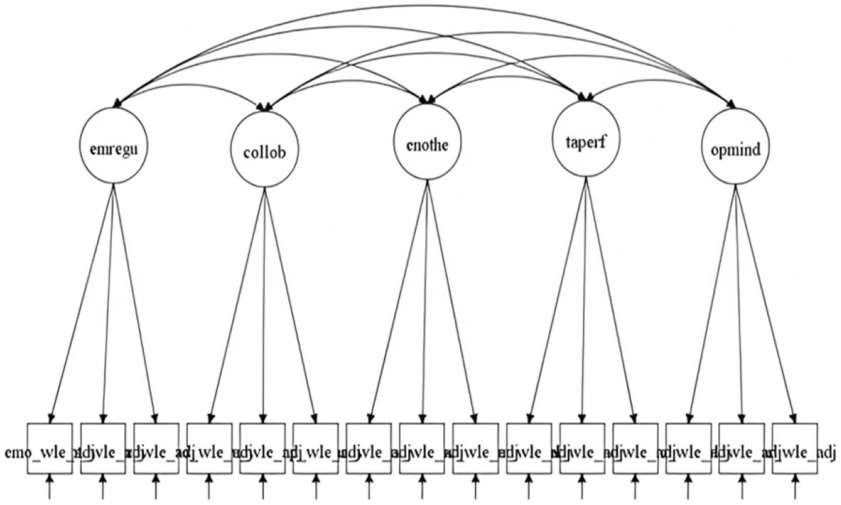

Table 1.
Descriptive statistics of mathematics achievement and SEL subdimensions

	Mean	Median	Std. Deviation	Skewness	Kurtosis
Mathematics achievement	29.15	28.86	10.52	-.031	-.864
Collaboration by					
Empathy	638.55	625.66	93.53	.784	1.004
Trust	502.27	504.64	84.69	-.376	2.231
Cooperation	627.54	617.99	85.54	.610	.608
Emotional regulation by					
Emotional control	512.30	510.40	88.72	.135	3.516
Optimism	535.73	537.08	93.39	.066	3.020
Stress resilience	512.09	514.62	111.85	-.129	2.061
Engaging with others by					
Assertiveness	521.59	514.14	110.77	.426	.848
Energy	561.97	555.38	93.08	.700	2.319
Sociability	583.52	575.32	91.54	.745	1.442
Open mindedness by					
Creativity	605.36	592.15	98.10	.881	1.220
Tolerance	621.04	605.37	111.15	.797	.780
Curiosity	628.48	614.18	91.13	.594	.185
Task performance by					
Persistence	608.48	600.16	102.15626	.610	.518
Responsibility	588.50	578.72	96.22337	.696	1.155
Self-control	607.07	603.97	95.05298	.656	1.155

Table 2.
Frequencies of groups.

Groups		*N*	*%*
Gender	Girls	1841	58.6%
	Boys	1299	41.4%
SES	Low	1046	33.3%
	Medium	1047	33.3%
	High	1045	33.3%
SEL Evaluation	No, we don't evaluate these skills	542	17.3%
	Yes, using informal evaluation	1392	44.3%
	Yes, using formal evaluation	855	27.2%

Table 3.
Confirmatory factor analysis of big five domain model.

Model	X^2	*df*	x^2/df	CFI	TLI	RMSEA	
						Value	90%
Model 1: 1-main domain, 15 sub-dimension	4233.838***	90	47.043	.650	.591	.121	.118, .124
Model 2: 5-main domain, 15 sub-dimension	2205.945***	80	27.574	.820	.764	.092	.089, .095
Model 3: 5-main domain, 10 subdimension	575.733***	25	23.029	.928	.871	.084	.078, .090

*p < .05; **p < .01; ***p < .001

one general factor and in Model 2, 15 subdimensions were hypothesized to be related to five main domains as described in the Big Five Model. Although Model 2 had better fit indices compared to Model 1, CFI, TLI and RMSEA values indicated that the fit was poor. Since the Big Five Model's fit indices showed that it did not adequately match the data, the model was modified by reducing the number of subdimensions in accordance with the lowest factor loadings.

The subdimensions with the lowest factor loadings were eliminated from the big five model. Therefore, tolerance (β = 0.501), self-control (β = 0.695), assertiveness (β = 0.393), trust (β = 0.314), and emotional control (β = 0.619) were removed with the lowest factor loadings in this model. Therefore, the model was modified as five domains and ten subdimensions (Model 3). Fit indices of the modified model indicated acceptable model fit with better CFI, TLI and RMSEA values. Overall, the model provided an acceptable fit (CFI = 0.928, TLI = 0.871, RMSEA = 0.084).

Predicting Mathematics Achievement

The modified 5-main domain, 10 subdimensions model of SSES was used to predict the mathematics achievement of students (see Table 4). According to the results, open-mindedness (β = 0.258) and emotional regulation (β = 0.398) main domains showed significant positive relationships with mathematics achievement. On the other hand, engaging with others (β = -0.516) main domain showed significant negative relationship with mathematics achievement. On the other hand, task performance and collaboration main domains did not have a statistically significant relationship with mathematics achievement. Overall, these five main domains explained 8% of the variance in mathematics achievement (R^2 = 0.077). Among these domains, engaging with others had the most important role in prediction.

Table 4.
Standardized regression coefficients for predicting mathematics achievement

Predictors	Standardized Coefficients	S.E.
Open mindedness	0.258***	0.053
Task performance	-0.049	0.056
Engaging with others	-0.516***	0.141
Collaboration	0.033	0.067
Emotional regulation	0.398**	0.127

*p < .05; **p < .01; ***p < .001

Differential relationship between SEL and mathematics achievement for related groups

To evaluate differential relationships, the analyses were conducted again for the gender, SES, and SEL evaluation groups.

Gender Groups

To determine whether relationships differ, mathematics achievement for each gender group was predicted using the SSES model. The findings demonstrated that whereas the model explained 6% of the variation in math achievement for boys (R^2 = 0.056), it explained 9% of the variation for girls (R^2 = 0.092). Thus, the model was able to explain more of the variation of mathematics achievement for girls than for boys.

Even though there was a significant positive relationship between the open-mindedness domain and math achievement for both boys and girls, the association was stronger for boys (β = 0.320) than for girls (β = 0.246). On the other hand, mathematics achievement of girls had a statistically significant positive relationship with emotional regulation (β = 0.412) and a statistically significant negative relationship with engaging with others (β = -0.419), but both domains did not have a statistically significant relationship with mathematics achievement for boys. Furthermore, there is no statistically significant relationship between math achievement for both boys and girls and task performance or collaborative domain.

Table 5.
Standardized regression coefficients in the model for boys and girls.

	Mathematics Achievement	Standardized coefficients	S.E.
Boys	Open mindedness	0.320***	0.089
	Task performance	-0.138	0.090
	Engaging with others	-0.348	0.214
	Collaboration	0.028	0.113
	Emotional regulation	0.185	0.194
Girls	Open mindedness	0.246***	0.063
	Task performance	0.012	0.068
	Engaging with others	-0.419**	0.152
	Collaboration	-0.064	0.075
	Emotional regulation	0.412**	0.134

*p < .05; **p < .01; ***p < .001

SES Groups

The SSES model was used to predict mathematics achievement for each SES group (low, medium and high) in order to determine whether or not the relationships differ (see Table 6). According to the results, the model explained 13% of the variance in mathematics achievement for students with low SES (R^2=0.130), 9% of the variance for students with middle SES (R^2=0.091). and 6% of the variation for students with high SES (R^2=0.056). Thus, the model explained more variance in mathematical proficiency for students from low SES than for children from medium and high SES.

While there was a statistically significant positive relationship between the open-mindedness domain and mathematical achievement for both low- and high-level SES groups (β = 0.507 and 0.170, respectively), the association was stronger for the former than for the latter. There was a statistically significant negative relationship between mathematical achievement and engaging with others for both low- and high-level SES groups (β = -0.606 and β = -0.471). Finally, only high SES groups showed a statistically significant positive correlation between mathematical achievement and the emotional regulation domain (β = 0.341). There was no significant relationship between any of the domains and math achievement for groups with a medium level SES.

Table 6.
Standardized regression coefficients for low, medium, and high-level SES

	Mathematics Achievement	Standardized Coefficients (β)	S.E.
Low SES	Open mindedness	0.507***	0.120
	Task performance	-0.166	0.145
	Engaging with others	-0.606*	0.279
	Collaboration	-0.089	0.105
	Emotional regulation	0.520	0.283
Medium SES	Open mindedness	0.073	0.126
	Task performance	-0.108	0.239
	Engaging with others	-0.955	0.769
	Collaboration	0.399	0.406
	Emotional regulation	0.691	0.640
High SES	Open mindedness	0.170*	0.082
	Task performance	0.104	0.080
	Engaging with others	-0.471**	0.174
	Collaboration	-0.031	0.076
	Emotional regulation	0.341*	0.149

*p < .05; **p < .01; ***p < .001

SEL Evaluation Groups

Mathematics achievement was predicted using the SSES model for the non-evaluated, informally evaluated, and formally evaluated SEL evaluation groups (see Table 7). According to the findings, this model accounted for 6% of the variance in mathematics achievement (R^2 = 0.062) for non-evaluated SEL groups, 8% of the variance (R^2 = 0.080) for informally evaluated SEL groups, and 9% of the variation for the SEL group that was formally evaluated (R^2 = 0.091).

Across all SEL evaluation levels, there was a statistically significant positive relationship between mathematics achievement and open-mindedness domain (β_non = 0.240, β_informally = 0.233, β_formally = 0.359). However, this relationship was getting stronger from non-evaluated groups to formally evaluated groups. Additionally, there were statistically significant negative relationships between the domains of engaging with others and mathematical achievement for groups of students who were formally evaluated (β = -0.482). Additionally, for this group, the emotional control domain and mathematical achievement were positively correlated (β = 0.343). Achievement in mathematics did not exhibit a statistically significant relationship with other domains in the non-evaluated and informally evaluated groups.

Discussion

The primary objective of this study is to examine the extent to which the Big Five domains of social and emotional skills can predict mathematics achievement among high school students in Turkey. Specifically, the study aims to explore whether the predictive power of these domains is moderated by factors such as gender, SES, and the level of SEL evaluation. This investigation is premised on the understanding that social and emotional competencies are crucial not only for personal well-being and social integration but also for academic success. By focusing on these competencies, the study seeks to provide a more nuanced understanding of how SEL is related to mathematics achievement, offering potential insights into how educational strategies can be tailored to meet the diverse needs of students (CASEL, 2020; OECD, 2021). The current study is significant not only because it applies the Big Five model to a Turkish context but also because it provides a detailed analysis of how SEL might influence mathematics achievement across different student groups. The findings have the potential to contribute to the broader literature on SEL by offering new insights into how social and emotional competencies interact with gender, SES, and school-level evaluation practices to shape academic outcomes. Moreover, the study's focus on mathematics achievement is particularly relevant given the global emphasis on STEM (Science, Technology, Engineering, and Mathematics) education as critical for future workforce development (OECD, 2021).

According to the results of the current study, the social and emotional skills domains accounted for 8% of the variance in mathematics achievement, particularly with open-mindedness, emotional control, and engaging with other factors. Thus, social and emotional skills have been shown to support academic achievement, which is consistent with previous research findings (Chernyshenko et al., 2018; McCormick et al., 2015; OECD, 2021).

The domains of emotional regulation and open-mindedness are positively related to students' proficiency in mathematics. Accordingly, the model suggests that students who have gained emotional control and an open mind typically perform better in math classes. The results align with the OECD's SSES report for every city that took place (OECD, 2021). Open-mindedness domain which was defined in the study as openness to experience with the combination of skills, curiosity, and creativity has significantly positive relationship with students' mathematics performance (Eroğlu et al, 2021; OECD, 2021). As a result, students who were classified as extremely creative and curious also said they were willing to learn new things, which leads to better academic performance (OECD, 2021). Additionally, there is a favorable correlation between mathematical achievement and the emotional regulation domain, which was defined as emotional stability with the combination of skills, stress resilience, and optimism (CASEL, 2020; Eroğlu et al, 2021). As a result, students who have mastered emotional regulation are more likely to perform better in mathematics.

On the other hand, engaging with others plays the most important role in predicting mathematics achievement in the sample data from Turkey. The outcome is in line with the OECD's SSES findings for the older group across all data. More social 15-year-old children receive lower math grades, according to the data. Individuals experience physiological and physical changes and are impacted by their peers during adolescence (Ahmetoglu, 2009; Gander & Gardiner, 2004). Teenagers' top priority during this time is getting their peers to accept them (Durualp, 2014). The study's conclusions might thus be linked to the reality that teens prioritize their relationships and social ties over academic success (OECD, 2021).

The differential relationship between SEL and mathematics achievement

One of the objectives of the current study was to use the big five domains model of SSES to predict mathematics achievement for various groups to investigate differential relationships. Having a general finding may not apply to every subgroup, thus the differential relationships offer a deeper understanding of a phenomenon, which is necessary to get better insight and use the findings efficiently. In order to examine differential relationships, the current study used gender, SES, and SEL evaluation level as subgroups.

The findings showed that explained variance of girls in math achievement was greater than boys. As a result, social and emotional competencies and mathematical achievement of girls were more correlated than boys. Previous research stated that gender differences have a key role in girls' better development of social and emotional skills compared to males' (Durualp, 2014; Kabakci & Korkut, 2010; Memis & Memis, 2013). Compared to boys, girls are found to have superior communication abilities and behaviors, including starting a discussion, adjusting, sustaining interaction, and being emotionally sensitive (Durualp, 2014; Kabakci & Korkut, 2010). Furthermore, mathematics performances of boys and girls who have higher curiosity and creativity skills are more likely to become more developed. On the contrary, more sociable and energetic girls are likely to have lower mathematics scores while boys' sociability and energy skills are not related to their mathematics performance.

The results showed that the explained variance in mathematical achievement was 13% for students from low socioeconomic backgrounds, 9% for students from medium socioeconomic backgrounds, and 6% for students from high socioeconomic backgrounds. Thus, it can be said that the social and emotional skills predicted math achievement more accurately for students from lower socioeconomic backgrounds. Therefore, students from disadvantaged socioeconomic backgrounds are likely to perform better academically in mathematics if they have acquired social and emotional skills. On the other hand, their performance in mathematics tends to suffer if they lack social and emotional skills. Thus, the current study shows how important it is to help pupils from low socioeconomic backgrounds.

According to the findings, this model accounted for 6% of the variation in math achievement for SEL groups that were not evaluated, 8% of the variation in math achievement for SEL groups that were evaluated informally, and 9% of the variation in math achievement. Thus, it can be said that the SSES model and mathematics achievement for evaluated SEL groups and non-evaluated groups have differential relationships. The findings supported the literature's assertion that SEL assessment and evaluation are critical components of the development of these abilities, which are linked to academic success (Agliati et al., 2020; CASEL, 2019; Sutton, 2021).

By providing empirical evidence on the relationship between SEL and mathematics achievement, the current study can inform the design and implementation of more effective SEL programs in Turkish schools. Additionally, it offers valuable

insights for policymakers and educators looking to enhance educational outcomes through targeted interventions that address the diverse needs of students. Ultimately, the study's findings could contribute to the development of a more equitable and effective educational system that supports the holistic development of all students, regardless of their gender, socioeconomic background, or the extent to which SEL is formally evaluated in their school.

Limitations

The study has limitations. One of the important limitation is that the current study was carried out using secondary data that was gathered by the OECD. Thus, the results from the study, which included students in the ninth, tenth, and eleventh grades in the Turkish sample, did not support the major five domains model of the OECD's SSES. As a result, the model was adjusted to exclude the subdimensions with the lowest factor loadings. For this reason, the model was examined using fewer subdimensions.

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