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Relationship between Learning and Teaching Variables and Mathematics Literacy in PISA 2012[i]

Öğrenme ve Öğretme Süreci Değişkenleri ile PISA 2012 Matematik Okuryazarlığı Arasındaki İlişkiler

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ABSTRACT. The purpose of this study was to determine the relationships between factors related to learning and teaching processes and mathematics literacy. The sample of this correlational study includes 4848 Turkish students. In this study, out-of-school learning time and learning time of mathematics are variables related to learning process. Teacher-student relation, teacher use of cognitive activation strategies, and disciplinary climate are variables related to teaching process. According to results of structural equation modelling analysis, negative relationship was found between out-of-school learning time and mathematics literacy while there was a positive relationship between teachers' use of cognitive activation strategies and mathematics literacy. Furthermore, mathematics literacy was found to have a negative relationship with student-teacher relation, but a positive relationship with positive disciplinary climate. When student-teacher relations were supported by positive disciplinary climate, the relationship between the two variables improved. Therefore, the content of courses should be enhanced in a way that teachers' classroom management skills are developed.
Keywords: Learning and Teaching Process, Mathematics Literacy, Mathematics Achievement, PISA, Structural Equation Modelling

ÖZ. Bu çalışmanın amacı öğrenme ve öğretme süreci değişkenleri ile matematik okuryazarlığı arasındaki ilişkileri araştırmaktır. Korelasyonel modeldeki araştırmanın örneklemini 4848 kişi oluşturmaktadır. Bu çalışmada, matematik öğrenmeye okul dışında ayrılan zaman, matematik öğrenmeye ayrılan zaman araştırmanın öğrenmeyle ilgili değişkenlerini oluşturmaktadır. Öğretmenin öğrenci ile iletişimi, bilişsel etkinleştirme stratejilerini kullanımı ve sınıftaki disiplin ortamı araştırmanın öğretme süreci ile ilgili değişkenleridir. Yapısal eşitlik modellemesi analizinden elde edilen sonuçlara göre öğrenmeye okul dışında ayrılan zaman ile matematik okuryazarlığı arasında negatif ilişki bulunurken öğretmenin bilişsel etkinleştirme stratejileri kullanması ile matematik okuryazarlığı arasında pozitif ilişki bulunmuştur. Ek olarak, matematik okuryazarlığı öğrenci-öğretmen ilişkisi ile negatif yönde ilişki gösterirken disiplin ortamı ile pozitif yönde ilişki göstermiştir. Öğrenci-öğretmen ilişkisi pozitif bir disiplin ortamı ile desteklendiğinde bu değişkenler arasındaki ilişki gelişmektedir. Bu yüzden, derslerin içeriği öğretmenlerin sınıf yönetimini geliştirecek yönde iyileştirilmelidir.
Anahtar Sözcükler: Öğrenme ve Öğretme Süreci, Matematik Okuryazarlığı, Matematik Başarısı, PISA, Yapısal Eşitlik Modellemesi

ÖZET

Amaç ve Önem: Bu çalışmanın amacı, PISA 2012 uygulamasında Türkiye örnekleminde, matematik okuryazarlığı ile ilişkili olan öğrenme ve öğretme süreci ile ilgili değişkenleri belirlemektir. Ülkemizin 2012 yılında katıldığı PISA uygulamasında, özellikle matematik okuryazarlığı açısından katılan kendisi gibi OECD üyesi ülkelerin ortalamasına kıyasla daha düşük ortalama göstermiştir ve Türkiye örneklemi oluşturan öğrencilerin çoğunun 2. düzey ve altında kalan yeterlik dilimindedir. Bu durumların, öğrenme ve öğretme sürecini de etkileyen öğrenci ve öğretmen özellikleri ile ilgili olması nedeni ile bu çalışma, öğrenme ve öğretme süreci ile ilgili faktörleri bir arada ele alması bakımından değerlidir.

Yöntem: Bu çalışma, Türkiye'deki 15 yaş öğrencilerinin PISA matematik okuryazarlığı ile matematik öğrenme ve öğretme süreçleri ile ilgili değişkenler arasındaki ilişkileri irdeleyen bir korelasyonel araştırmadır. Örnekleme yapılırken Türkiye'de uygulamaya katılacak öğrencilerin seçiminde iki aşamalı tabakalı örneklem kullanılmıştır. İlk tabakayı 15 yaş grubu öğrencilerin bulunduğu okullar, ikinci tabakayı ise bu okullardaki 15 yaş grubundaki öğrenciler oluşturmaktadır. Bu şekilde 4848 kişi seçilmiştir. Çalışmanın verileri, PISA 2012 uygulamasına katılan öğrencilerin cevaplamış olduğu "Öğrenci Anketi"nden ve "Matematik Okuryazarlığı Testi" nden elde edilmiştir. İlgili araştırmalar doğrultusunda, modele hangi değişkenlerin dâhil edileceği belirlenerek model oluşturulmuştur. İlgili

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alan yazın bulguları doğrultusunda belirlenen değişkenler; matematik öğrenimine ayrılan zaman, okul dışında ders çalışmak için ayrılan zaman ve öğretmenin bilişsel etkinleştirme yöntemlerini kullanması, sınıftaki disiplin ortamı, öğrenci-öğretmen ilişkisi ve matematik okuryazarlığıdır. Araştırmada araştırma sorularına yanıt vermek amacıyla yapısal eşitlik modellemesi (YEM) yapılmıştır

Bulgular: Ele alınan diğer değişkenler arasında kurulan ilk yapısal model için kestirilen uyum indeksleri genellikle iyi uyum veya kabul edilebilir uyum sınır aralıkları içerisindedir. Öte yandan, χ^2, p, χ^2/sd, NNFI ve CFI değerlerinin kabul edilebilir sınır aralıklarının içerisinde olmadığı görülmektedir. Bu değerlerin kötü uyumu işaret etmesi nedeniyle analiz sonucunda programdan çıkan düzeltme önerileri incelenerek model yeniden oluşturulmuş ve test edilmiştir. χ^2, p, χ^2/sd uyum indekslerinin örneklem büyüklüğünden etkilenmesi sebebiyle bu değişkenler dışında diğer uyum indeksleri modelin iyi uyum sağladığını göstermiştir. Düzeltme öncesi matematik okuryazarlığı ile ilişkili değişkenler ile oluşturulan yapısal modelin kötü uyum gösterdiğini belirten NNFI ve CFI değerleri, düzeltme sonrasında modelin iyi uyum gösterdiğini belirtmiştir. YEM analizi sonuçlarına göre öğrenmeye okul dışında ayrılan zaman ve öğrenci-öğretmen ilişkisi değişkenleri ile matematik okuryazarlığı arasında negatif yönde istatistiksel olarak manidar bir ilişkinin olduğu, öte yandan sınıftaki disiplin ortamı ve bilişsel etkinleştirme stratejilerinin kullanılması ile matematik okuryazarlığı arasında pozitif yönde istatistiksel olarak manidar bir ilişkinin olduğu bulunmuştur. Bu bulguların yanı sıra, bilişsel etkinleştirme stratejisi değişkeni ile öğrenci-öğretmen ilişkisi değişkeni arasında pozitif yönde manidar bir ilişkinin olduğu bulunmuştur. Ancak, öğrenci-öğretmen ilişkisi değişkeni aracılık ettiğinde öğretmenin bilişsel etkinleştirme stratejilerini kullanması ile öğrencilerin matematik okuryazarlığı arasında negatif yönde manidar ilişki olduğu sonucuna ulaşılmıştır. Ek olarak, araştırmada, öğrenci-öğretmen ilişkisi ile sınıftaki disiplin ortamı arasında pozitif yönde istatistiksel olarak manidar bir ilişki olduğu elde edilmekle beraber öğrenci-öğretmen ilişkisinin sınıftaki disiplin ortamı aracılığıyla matematik okuryazarlığı ile arasında pozitif yönde bir ilişki olduğu sonucuna ulaşılmıştır.

Tartışma, Sonuç ve Öneriler: Matematik okuryazarlığı ile en yüksek ilişkili olan değişkenin sınıftaki disiplin ortamı olduğu sonucuna ulaşılmıştır. Öğretmenlerin öğretmen yetiştirme programlarında almış oldukları derslerin içeriklerinin öğretmenin sınıf yönetimi becerilerinin gelişmesini sağlayacak, bilişsel etkinleştirme stratejilerin etkili bir şekilde kullanılmasını öğretecek yönde geliştirilmesi veya yeni derslerin açılması sağlanabilir.

INTRODUCTION

In the Program for International Student Assessment (PISA), mathematics literacy is defined as "an individual’s capacity to identify and understand the role that mathematics play in the world, to make well-founded judgments and use and engage with mathematics in ways that meet the needs of that individual’s life as a constructive, concerned and reflective citizen” (Ministry of National Education [MoNE], 2010, p. 101). Competencies assessed in PISA are predictors of students’ future success (Schleicher, 2007). That is why the results obtained from PISA are important. What is more, it provides countries with critical reviews of their schools' performance in comparison with other countries. In the light of these results, countries can revise their education systems.

PISA addresses social, cultural, economic and educational factors that are considered to be associated both with student achievement. Several of these factors are related to teaching and learning process, which is the central point of education. Turkish students' poor performance may be related to this process. Specifically, the results of PISA 2012 showed that in their overall performance, Turkish students ranked 44th out of 65 countries (OECD, 2013a). Therefore, it is crucial to investigate the possible reasons behind the low performance of students in mathematics using the dimensions of teaching and learning process. In this regard, in the present study, the following student-level variables regarding the teaching and learning process were addressed: Learning time in school lessons, out-of-school learning time, disciplinary climate, teacher-student relation and teacher’s use of cognitive activation strategies.

Theoretical framework

In the field of educational psychology, there are several models related to teaching and learning process focusing on how students learn effectively and what factors facilitating students' learning. One of these models is Bloom's Mastery Learning Model. According to Bloom's Mastery Learning Model, the main reason for the learning differences in individuals is due to teaching and learning process. To put it differently, teaching and learning process is one of the variables determining differences in learning (Bloom, 1968). This process, which is also referred to as instructional quality increases or decreases the achievement of the students. Considering the important role of the teaching and learning process on student achievement and the quality of education, this study explored the relationship between the variables regarding this process and mathematics literacy.

Several research studies revealed that learning time (Kaur & Areepattamannil, 2013; Usta, 2014) have an effect on students achievement. The variable learning time is the amount of time that students spend on regular school lessons and out-of-school-time lessons (OECD, 2011). Optimizing academic learning time is one of the critical factors affecting academic achievement. However, learning time is necessary, but not sufficient, for acquiring knowledge. More precisely, learning ultimately depends on how time is organized, the proportion of time dedicated to students' engagement in learning and the time that students require to grasp concepts and elaborate ideas (Carroll, 1989).

Disciplinary climate has also an important role on students' academic achievement (Akyüz & Pala, 2010). In a negative disciplinary climate, interruptions take place in classrooms, which may hinder students' levels of engagement (OECD, 2013a). What is more, in the presence of this kind of classroom atmosphere, students' confidence in and respect for the teacher may be negatively affected (Cheema & Kitsantas, 2014).

The relationship between teacher-student relation and mathematics literacy was also examined in the current study. PISA suggests that positive and constructive teacher-student relation can be a key vehicle to improve students' achievement (Mireles-Rios & Romo, 2010; OECD, 2015). By praising students' noteworthy effort sufficiently, teachers boost students' intrinsic motivation to achieve (Cotton, 1988). If the students like their teachers and have a good communication with their teachers, they will put more effort and thus their achievement will increase (Montalva, Mansfield & Miller, 2007).

The last variable investigated in the present study was the teacher's use of cognitive activation strategies. In the literature, studies have shown that students who are cognitively active and engage in their learning process have a higher level of mathematics achievement (Baumert et al., 2010; Davis-Langston, 2012; Hendrick, 2013). Cognitive activation refers to teaching pupils several strategies, such as summarizing, questioning and predicting, which they can use when solving math problems. These strategies enable pupils to think more deeply in order to find solutions and to make a decision which method they use to reach the answer. What is more, these strategies encourage students to make connections between mathematical facts, procedures and ideas, which will result in enhanced learning (Burge, Lenkeit & Sizmur, 2015).

Turkish Education System

In all over the world, considering contemporary approaches toward teaching and learning, there have been ongoing changes in countries' curriculum. Specifically, Turkish curriculum developers modified the curriculum which encourages children's construction of their knowledge. Especially, after several international studies such as PISA and *Trends in International Mathematics and Science Study (*TIMSS) pointed out that Turkey lag considerably behind most of OECD countries on three domains, namely mathematics, science, and reading, policy makers are forced to take several steps to increase the quality of the education system. At this point, to make this happen, MoNE which is responsible for the Turkish centralized education system has been carrying out reforms.

In Turkey, MoNE implemented new elementary curriculum in 2004-2005. The national curriculum for mathematics and science were modified in the light of the constructivist theory of education (Gökmenoğlu & Clark, 2015). More precisely, some of the goals were restated to enhance students' independent thinking skills and the application of mathematics in other disciplines and in daily life (Bayazit, 2013).

In the new program, there is also change in learning and teaching environments. Accordingly, the roles of the students and teachers have been redefined in this program. While the teacher was perceived as the center of the teaching and learning process in the old curriculum, in the new curriculum, teachers are considered to be facilitators and the students are given responsibility for their own learning. Teachers are expected to use a variety of teaching strategies to attract students' attention and make them be active in the learning environment (Koc, Isıksal & Bulut, 2007).

The Present Study

In the international context, a major gap has been identified. In spite of a fast-growing body of PISA secondary analysis studies, teaching and learning variables have hardly been explored. In the national context, although MoNE implemented the compulsory mathematics curricula considering the constructivist approach in response to the disappointing results of international assessments, traditional ways of learning still continue to exist in teaching and learning process (Ozar, 2012). However, very little information has been reported about the relationship of mathematics literacy with the variables which shows the quality of the teaching and learning process on students' achievement in a Turkish setting. Also, the review of the literature points out that there is an inconsistency in the association of these variables with mathematics literacy. In addition, it is anticipated that this study will provide a deeper understanding of the association of these variables with students' mathematics literacy. Considering the role of teacher education programs in teacher quality which in turn affects the teaching process and quality of teaching, this study also provides valuable information about teacher education programs and education policy. Moreover, there have been limited studies examining indirect effect of these variables on mathematics literacy. In the light of the findings gleaned from the international and the Turkish literature, this study investigates the relationships between these variables and mathematics literacy as addressed in the PISA 2012.

For this purpose, the following research questions were investigated:

(1). Is there a statistically significant relationship between students' mathematics literacy and

(1.a) Learning time for mathematics in school?

(1.b) Out-of-school learning time?

(1.c) Disciplinary climate?

(1.d) Teacher-student relations?

(1.e) Teacher's use of cognitive activation strategies?

(2). Is there a statistically significant relationship between teacher's use of cognitive activation strategies and

(2.a) Teacher-student relation?

(2.b) Students' mathematics literacy (ML) through teacher-student relation?

(2.c) Students' mathematics literacy (ML) through both teacher-student relation and disciplinary climate?

(3). Is there a statistically significant relationship between teacher-student relation and

(3.a) Disciplinary climate?

(3.b) Students' mathematics literacy (ML) through disciplinary climate?

METHOD

Population and Sample

PISA 2012 Turkish population is composed of 1.266.638 15-year old students. The target population of this study consisted of 965.736 students who were aged between 15 years 3 months and 16 years 2 months and were enrolled in public or private school.

The sampling design used for the PISA assessment of Turkey was a two-stage stratified sampling. The first stage consisted of sampling 170 individual schools in which 15-year-old students could be enrolled. Schools were systematically sampled with probabilities proportional to size. In the second stage, 15-year-old students were randomly selected (OECD, 2014). As a result, 4848 students were selected as a Turkish sample

Data Collection Tools

The data used in this study was obtained from the PISA 2012 student questionnaire and the mathematics literacy test.

Student Questionnaire

This questionnaire contains information about students' family background and aspects of instruction. Students are given 30 minutes to complete the questionnaire. Items of teaching and learning variables addressed in student questionnaire were presented in Table 1:

Table 1. *Teaching and Learning Variables and Their Corresponding Items*

Variable Name	Items
Learning time spend on school lessons (LMINS)	Minutes in a <class period> in mathematics Number of <class periods> per week in mathematics
Out-of school learning time (OUTHOUR)	Homework or other study set by your teachers Out of the time spent in doing homework with somebody overlooking and providing help if necessary Work with a personal <tutor> (whether paid or not) Attend out of school classes organized by a commercial company, and paid for by your parents Study with a parent or other family member Repeat and train content from school lessons by working on a computer
Disciplinary climate (DISCLIMA)	Students don't listen to what teacher says There is noise and disorder. The teacher has to wait a long time for students to <quiet down>. Students cannot work well. Students don't start working for a long time after the lesson begins.
Teacher-student relation (STUDREL)	Students get along with their teachers Teachers are interested in their [students'] personal well-being Most of my teachers really listen to what I have to say. If I need extra help, I will receive it from my teachers. Most of my teachers treat me fairly.
Teachers' use of cognitive activation strategies (COGACT)	The teacher asks questions that make students reflect on the problem The teacher gives problems that require students to think for an extended time The teacher asks students to decide, on their own, procedures for solving complex problems The teacher presents problems having no obvious solutions The teacher presents problems in different contexts so that students know whether they have understood the concepts The teacher helps students to learn from mistakes they have made The teacher asks students to explain how they solved a problem The teacher presents problems that require students to apply what they have learned in new contexts; The teacher gives problems that can be solved in different ways

Mathematics Literacy Test

The mathematics literacy of students covers four content areas of mathematics, namely space and shape, change and relationship, quantity and uncertainty. The mathematics literacy test consists of 110 questions, which contain multiple choice, complex multiple choice, short answer and open ended questions (Thomson, De Bortoli & Buckley, 2013). Two hours were given to students to complete the test. For PISA 2012, the Rasch model, was used to estimate the average scores in mathematics literacy. Mathematics literacy scores of students are considered to be plausible values since each student completes only a subset of items (OECD, 2012). In this study, all five plausible values were used to provide a true representation of students' mathematics literacy.

Data Analysis

To explore the research questions, a structural equation modeling, analysis (SEM) was performed using the LISREL 8.1 software. SEM was chosen since it takes into account the measurement errors. Therefore, it provides more reliable results (Kline, 2005). "SEM adopts a confirmatory, hypothesis-testing approach to the data. This requires researchers to build a hypothesis based on previous studies" (In'Nami & Koizumi, 2013, p. 24). In this regard, in this study, the relationship among the variables were constructed based the findings of the previous studies. Before the SEM analysis, preliminary analyses were conducted to ensure that there was no violation of the assumptions.

RESULTS

The measurement models were tested by performing CFA (confirmatory factor analysis). Then, the explained variance and reliability of latent constructs were calculated to determine whether the observed variables represented their corresponding latent variables. The coefficients of the construct reliability ranged from .57 to .98 and explained variance varied from .25 to .92. However, negative degree of freedom was found for the variable "learning time spend on school lessons". Therefore, no measurement model was identified for this variable.

To determine the internal consistency, a reliability analysis was performed and Cronbach's alpha values were calculated for each latent variable. *t*-values of all observed variables were found to be statistically significant ($p<.05$). In other words, items are considered to be reliable indicators of their corresponding latent variables. Also, the reliability coefficients of the variables, namely out-of-school learning time, teacher's use of cognitive activation strategies, disciplinary climate, teacher-student relation and mathematics literacy ranged from .60 to .92. Based on the criterion of Kalaycı (2006) that reliability coefficients should be equal to or higher than .60, all subscales were reliable.

Once measurement models were identified, the structural model in which the relationships between exogenous latent variables and endogenous latent variables were defined was tested. The unmodified version of the model and standardized path coefficients are given in Figure 1.

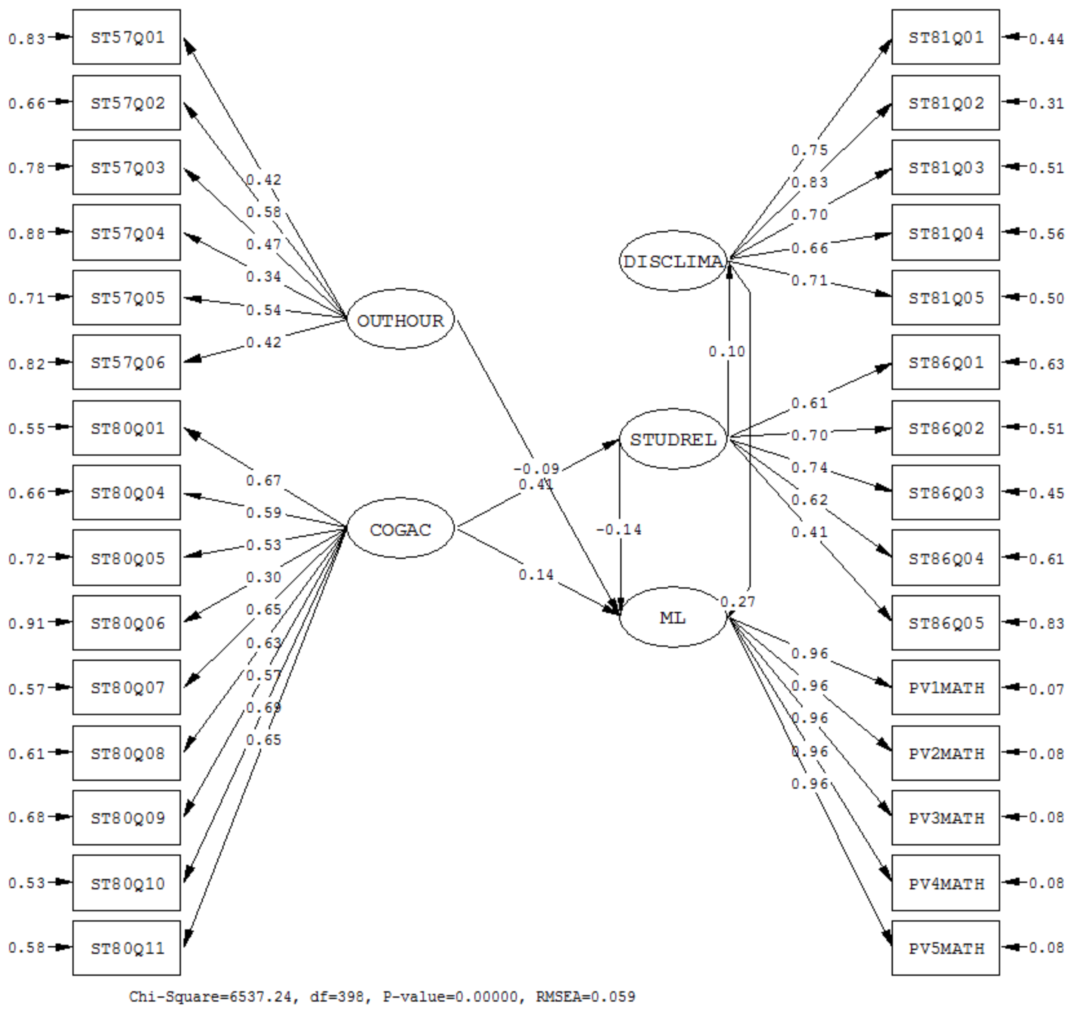

Figure 1. *Unmodified Version of the Structural Model*

When the fit indices were evaluated, it was found that fit indices and relationships among variables should be revised. The Table 2 presents the fit indices of the unmodified version of the model and decision about the fitness of the model to the data according to the criteria of Kline (2005) and Tabachnick and Fidell (2007).

Table 2. *Fit Indices'Values of Unmodified Structural Model*

Fit Indices	Good Fit	Acceptable Fit	Value	Decision
χ^2	$.00 \le \chi^2 \le 2df$	$2df \le \chi^2 \le 3df$	5484.66	Bad fit
p	$.05 \le p \le 1.00$	$.01 \le p \le .05$	.00	Bad fit
χ^2/df (6537.39/398)	$.00 \le \chi^2 \le 2$	$2 \le \chi^2 \le 3$	16.43	Bad fit
RMSEA	.00≤RMSEA≤.05	.05<RMSEA≤.08	.06	Acceptable fit
RMSEA Confidence Interval	Confidence Interval ≤.10		.058- .060	Good fit
SRMR	.0≤SRMR≤.05	.05<SRMR≤.10	.06	Acceptable fit
NFI	.95≤NFI≤1	.90≤GFI<.95	.94	Acceptable fit
NNFI	.97≤NNFI≤1	.95≤CFI<.97	.94	Bad fit
CFI	.97≤CFI≤1	.95≤CFI<.97	.94	Bad fit
GFI	.95≤GFI≤1	.90≤GFI<.95	.91	Acceptable fit
AGFI	.90≤AGFI≤1	.85≤AGFI<.90	.90	Good fit

Note. χ^2 = Chi-square; χ^2/df = Chi-square/ degrees of freedom; RMSEA = Root Mean Squared Error of Approximation; SRMR = Standardized Root Mean Square Residual; NFI = Normed Fit Index; NNFI = Non-normed fit index; CFI = Comparative Fit index; GFI = Goodness of Fit Index; AGFI = Adjusted Goodness of Fit Index

As seen in Table 2, the fit indices indicated that the first structural model showed an acceptable or good fit to the data. However, it was found that the values of χ^2, p, χ^2/df, NNFI and CFI fell outside the acceptable range leading to a revision. Modifications were made based on theoretical considerations or evidence from prior studies that would result in a statistically significant decrease in χ^2.That is, error covariance was added between the items which are similar to each other regarding their content. Table 3 presents the fit indices of the modified version of the model.

Table 3. *Fit Indices' Values of Modified Structural Model*

Fit Indices	Good Fit	Acceptable Fit	Values	Decision
χ^2	$.00 \leq \chi^2 \leq 2df$	$2df \leq \chi^2 \leq 3df$	3605.63	Bad fit
p	$.05 \leq p \leq 1.00$	$.01 \leq p \leq .05$	.00	Bad fit
χ^2/df (3605.63/393)	$.00 \leq \chi^2 \leq 2$	$2 \leq \chi^2 \leq 3$	9.17	Bad fit
RMSEA	.00≤RMSEA≤.05	.05<RMSEA≤.08	.04	Good fit
RMSEA Confidence Interval	Confidence interval ≤.10		.042-.044	Good fit
SRMR	0≤SRMR≤.05	.05<SRMR≤.10	.05	Good fit
NFI	.95≤GFI≤1	.90≤GFI<.95	.96	Good fit
NNFI	.97≤CFI≤1	.95≤CFI<.97	.97	Good fit
CFI	.97≤CFI≤1	.95≤CFI<.97	.97	Good fit
GFI	.95≤GFI≤1	.90≤GFI<.95	.95	Good fit
AGFI	.90≤AGFI≤1	.85≤AGFI<.90	.94	Good fit

As shown in Table 3, most fit indices showed a good fit of the modified version of the structural model except for the indices X^2, p, X^2/df. A possible reason for the high value of these indices might be the large sample size (n=4415). While NNFI and CFI demonstrated a poor fit of the unmodified version of the structural model, these indices showed a good fit of the modified version. The modified structural model of mathematics literacy was shown in Figure 2:

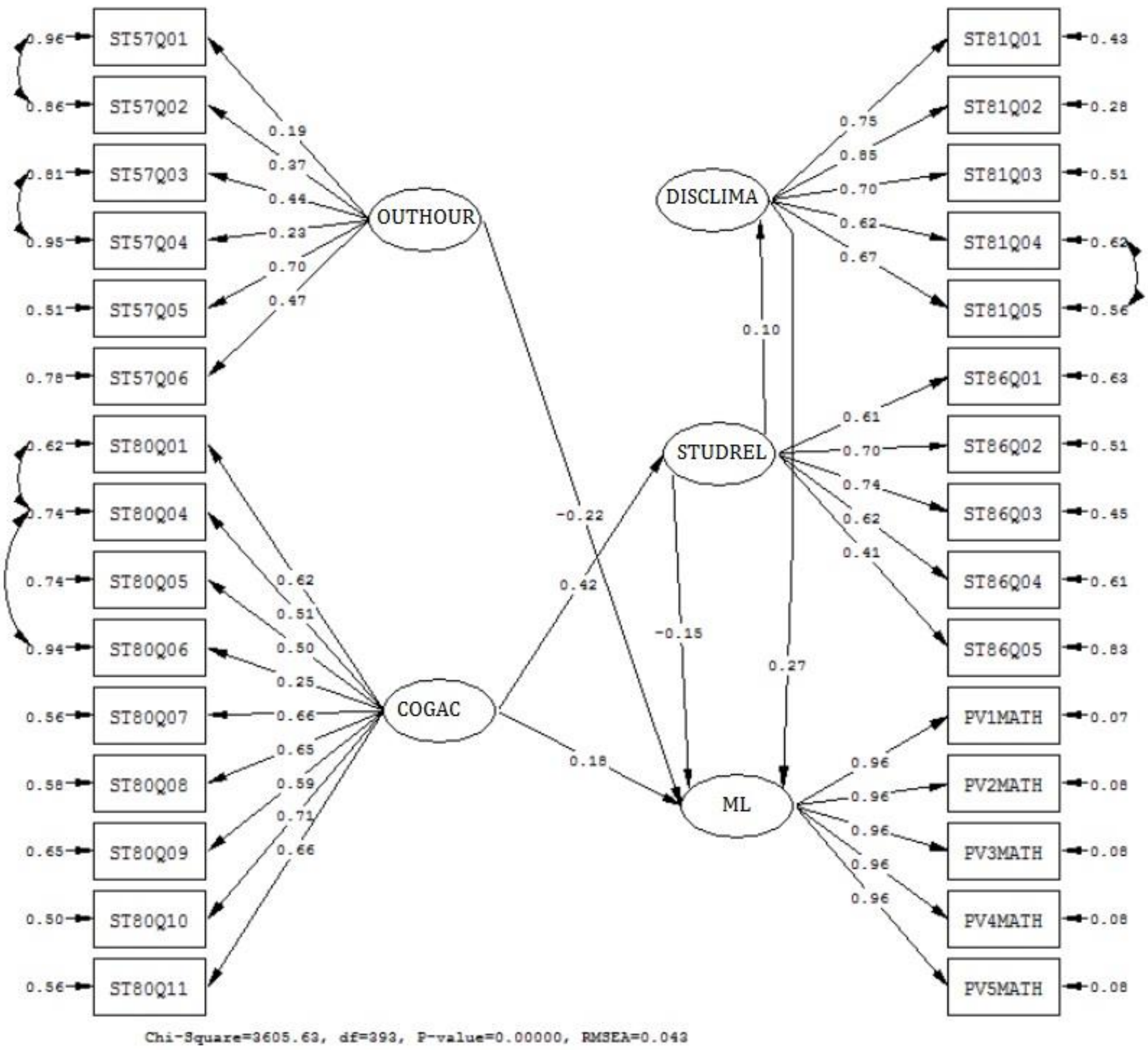

Figure 2. *Modified Structural Model*

Table 4 presents the direct effects, standardized factor loadings and t-values of these effects, standardized factor loadings of indirect effects and structural equations:

Table 4. *Values of Direct Effects, Indirect Effects and Structural Equations*

Direct Effects	**Unstandardized**	**Standardized**	**Loadings**	***t*-values**
OUTHOUR → ML	-28.86	-.22		-7.67
DISCLIMA → ML	37.52	.27		16.71
STUDREL → ML	-31.88	-.15		-7.66
COGAC → ML	28.07	.18		9.42
COGAC → STUDREL	.30	.42		19.39
STUDREL → DISCLIMA	.15	.10		5.33
Indirect Effects				**Standardized Loadings**
COGAC → STUDREL → ML				-.06
COGAC → STUDREL → DISCLIMA → ML				.01
STUDREL → DICLIMA → ML				.03
Structural Equations				**R^2**
DISCLIMA= .15xSTUDREL				.01
STUDREL= .30xCOGACT				.17
ML = 37.52xDISCLIMA - 31.88xSTUDREL - 28.86xOUTHOUR+ 28.07xCOGACT				.14

As seen in Table 4 and Figure 2, there was a statistically significant negative relationship between out-of-school learning time and mathematics literacy (γ =-.22, p<.05). In other words, students who spend their time on mathematics learning at a level above the average tend to have below-the-average mathematics literacy scores.

Another important finding of this study was that there was a statistically significant positive relationship between disciplinary climate and mathematics literacy (β =.27, p<.05). This means that students tend to have above-the-average mathematics literacy scores in the classroom where positive disciplinary climate atmosphere is established.

According to the results of the SEM analysis (Table 4 and Figure 2), teacher-student relation was negatively correlated with mathematics literacy (β =-.15, p<.05). Accordingly, students who have their relation with their teacher at a level above the average tend to have below-the-average mathematics literacy scores.

Considering the relationship between the teacher's use of cognitive activation strategies and mathematics literacy, a statistically significant positive relationship was found between these two variables as stated in Table 4 and Figure 2 (γ = .18, p<.05). In other words, as the teacher performs activities that encourage students to be active in the process of learning and presents problems that require thinking, students' score in mathematics literacy increases.

As shown in Table 4 and Figure 2, a statistically significant positive relationship was found between teachers' use of cognitive activation strategies and teacher-student relations (γ = .42, p<.05). That is, the use of strategies encouraging students to be more active and to think and participate in the process of learning helps establishing good communication between students and teachers. Depending on this relationship, teacher's use of cognitive activation strategies explained 17 % of the observed variance on teacher-student relation (R^2 = .17).

Teacher's use of cognitive activation strategies also has an indirect effect on students' mathematics literacy. The relationship between the teacher's use of these strategies and mathematics literacy was found to be -. 06 and statistically significant when teacher uses such strategies by establishing positive relation with students. On the other hand, when positive teacher-student relation was supported with a positive disciplinary climate, the relationship between the two variables was found to be ".01" and statistically significant. This means that teacher's use of cognitive activation strategies positively contributes to students' mathematics literacy only when positive teacher-student relations are built under certain disciplinary rules.

The results of the analysis showed that teacher-student relation and disciplinary climate were found to be positively correlated (β =.10, p<.05). Positive teacher-student relation contributed to creating a positive disciplinary climate. Furthermore, teacher-student relation explained 1 % of the observed variance in disciplinary climate (R^2 =.01). Another finding of this study was that the relationship between teacher-student relation and mathematics literacy was ".03" and statistically significant when a disciplinary climate was established in a positive manner. This means that as teachers get along with the students in the classroom where a positive disciplinary climate is built, mathematics literacy scores of their students increase.

As a result, as shown in Table 4, disciplinary climate, teacher-student relation, out-of-school learning time and teacher's use of cognitive activation strategies accounted for 14 % of the explained variance in mathematics literacy (R^2=.14). The strongest predictor of the mathematics literacy was disciplinary climate while the weakest predictor was teacher-student relation.

DISCUSSION

In this study, when the relationship among the variables were examined separately, it was found that student who spent more time on mathematics learning out of the school have a tendency to get a lower score in mathematics literacy. This finding is consistent with that of the study by Kaur and Areepattamannil (2013). In their study, time spent on private tuition to remedy deficiencies in mathematics and Australian students' mathematics literacy was found to be negatively correlated. These researchers attributed this result to the fact that mathematics as a school subject is different from mathematics literacy. Similarly, this finding of the current study is parallel to the study in which mathematics literacy of students from Turkey and Finland obtained from the results of PISA 2003 and PISA 2012 was compared and a statistically significant negative relationship was found between mathematics literacy and out-of school learning time of students from Finland (Usta, 2014). In addition, according to a report published by the Bureau of Research and Development of Education (EARGED) in 2010, students who performed lower in PISA spent less time in school and more time on out-of school for learning. This points out that it is the quality of school lessons, not the quantity of learning time that has the most influence on students' learning. In this report, it was further emphasized that this negative relationship might be due to low performers who take private tuition, enroll in private institutions, and have to remedy their deficiencies in mathematics.

As a result of the SEM analysis, the more positive disciplinary climate a classroom has, the higher mathematics literacy scores the students get. This finding is consistent with the findings of other studies in the literature (Cheema & Kitsantas, 2013; İş, 2003). The reason for a positive relationship between the positive disciplinary climate and mathematics literacy could be that teachers do not spend time on coping with disciplinary problems when a positive disciplinary climate is established. Rather, they use this time to teach mathematics and provide students with various activities. In addition, in these classrooms, students are more willing to participate in lessons, they feel they belong at school, easily focus on the topic covered in the lesson, all of which increase the mathematics achievement of these students (EARGED, 2010). On the other hand, classroom disruption may lead to students and teachers losing their concentration and interest in lessons and thus eventually negatively affecting students' achievement (Smith & Laslett, 1992).

In this study, it was that the teacher-student relation was negatively correlated with students' mathematics literacy. Mikk et al. (2015), who investigated teacher-student relations and PISA 2009 results of several countries, also found the similar results for Turkey. A positive teacher-student relationship may cause a disruption in the balance between the teacher's role as a leader and student's role a learner. In other words, professional boundaries between teachers and students may not be maintained. The teacher should be friendly, but not a friend (Selimoğlu, 2009). Otherwise, students do not give enough emphasis on lessons since they do not see their teachers as leaders. They may also have an attempt to skip the class and not to give enough effort in the lesson (Akyüz & Pala, 2010). In addition, one other possible explanation for the negative correlation between positive teacher-student relation and mathematics literacy is that teachers usually focus on helping and supporting, and mostly communicate with low-achieving students (Curwin & Mendler, 1988). This slows down the pace of instruction and may result in not covering all the topics in mathematics during the academic term. Furthermore, dependency in a teacher-child relationship may cause a lower academic performance. To be more precise, students who are overly dependent on their teacher may have a tentative engagement with the class environment and they may not believe that they can succeed without the support and guidance of their teachers, which would result in low academic achievement (Birch & Ladd, 1997).

In the literature, despite the several studies reporting a statistically significant positive correlation between teacher-student relations and students' mathematics literacy, there are also others that found no significant correlation between these two variables (Mireles-Rios & Roma, 2010; Yılmaz, 2006). A possible explanation for these different findings may be the cultural differences between countries. In several countries, students have relatively strong respect for teachers and views teachers as a leader, which helps maintain the boundary between the students and their teachers. This positively affects students' mathematics achievement (Shin, et al., 2009). On the other hand, Yılmaz (2006), who used PISA 2003 data and a Turkish sample similar to the present study found a positive correlation between positive teacher-student relation and students' mathematics literacy. The reason for inconsistency with the result of the current study might be due to the educational reform that occurred in Turkey in 2005. At the time when Yılmaz (2006) conducted the study, teachers' leadership skills were the prominent qualification. In other words, teachers were seen as authority figures by students. This is why students had high respect for their teachers and studied harder in lessons. This might have positively contributed to their academic achievement. With Turkish curriculum reform, teacher's role changed from a leader to a facilitator and more emphasis was given on teacher-student relation (Ocak, 2010). However, if a boundary of teacher-student relation is not precisely predetermined, this would negatively affect students' academic performance.

In this study, students whose teachers use cognitive activation strategies frequently were found to have high levels of mathematics literacy. In the literature, several studies have reported similar results (Davis-Langston, 2012; Hendrick, 2013). A possible reason for the positive relationship may be level of teachers' pedagogical content knowledge that have a positive effect on the level of cognitive activation. The more a teacher knows about how instructional content can be made accessible to students, the more challenging the instruction becomes. Hence, as the students are cognitively activated, their level of mathematics literacy starts getting positively affected (Baumert et al., 2004). Being more active in their learning environment also helps students develop critical thinking skills, which could be another reason for the positive relationship between teachers' use of cognitive activation strategies and mathematics literacy (Hendricks, 2013). Critical thinking activates cognitive skills and refers to developing new ideas and alternative solutions to arrive at a decision on what to do (Sun & Hui, 2011). These skills help students to develop problem solving skills (Türnüklü & Yeşildere, 2005). Students with high-level problem-solving skills are able to analyze a situation and make decisions, and simultaneously manage multiple conditions. As a result, a high level of problem solving skills positively contributes to students' mathematics literacy.

The results also showed that teacher's use of cognitive activation strategies also positively affects their relationship with students. This finding is also supported by another study (Baroody, Rimm-Kaufman, Larsen & Curby, 2014). Teacher's use of these strategies may depend on their beliefs about and attitudes towards the lessons. More precisely, teachers with positive beliefs about and attitudes towards lessons are more likely to use such strategies and tend to develop positive relationships with students (Beets et al., 2008). When using these strategies, teachers continually communicate with students and encourage them to learn from their mistakes. As a result, students are more willing to participate in class, which can improve the teacher-student relationship (OECD, 2014).

In this study, teachers' use of cognitive activation strategies and students' mathematics literacy were found to be negatively correlated when students have their relation with their teacher at a level above the average. On the other hand, teacher's use of these strategies and students' mathematics literacy were positively correlated when such a relationship was established in a positive disciplinary climate. This finding is consistent with another study of (Selimoğlu, 2009), who examined disciplinary problems of elementary and secondary students and reported that the failure to determine the boundaries of teacher-student relations leads to disciplinary problems and a lower level of mathematics literacy.

In the current study, improving students' relationship with their teachers and helping them whenever they need were found to positively correlate with the disciplinary climate in the classroom. This finding is consistent with other study (Birch & Ladd, 1997). This may be because students who have a closer relationship with their teachers believe that their teacher treat them fair and listen to their concerns. Thus, problems such as excessive noise in the classroom are eliminated and students start on working on time (Pianta & Stuhlman, 2004). On the other hand, teachers who have a conflictual relationship with their students persistently display violent behaviors. In this case, students consider that aggression is a way of coping with conflict.

To sum up, as far as the relationship between each of the variables regarding teaching and learning and students' mathematics literacy is concerned, the findings of this study make important contributions to the research literature on PISA. Given the scant attention paid to Turkish students in PISA-related studies, this study certainly constitutes a positive attempt to fill in this research gap. By investigating teaching and learning variables, it provides a deep understanding of how these factors related to Turkish students' mathematics performance. Also, this study produced mathematics literacy models for Turkish students based on PISA 2012 data.

CONCLUSION AND IMPLICATIONS

This study provides several implications for educational research and practice. Firstly, the fact that students spending more time on out of school learning tend to have a lower mathematics literacy score puts forward the importance of education in school. Therefore, it is recommended that more emphasis should be given to school effectiveness rather than private tuition or private institutions.

In this regard, this study suggests that the activities in textbooks be revised in a way that students will be more active in their learning process.

Secondly, considering the results of this study, teachers should establish a positive disciplinary climate in classrooms to contribute to students' mathematics literacy. At this point, the related finding highlights the importance of teachers' classroom management skills. Therefore, the quality of the course "Classroom Management" offered in teacher education programs to teacher candidates could be enhanced. Thirdly, the negative relationship found between teacher-student relation and mathematics literacy. It highlights the importance of determining the aspects of the teacher - child relation. In this context, this study suggests that seminars and in-service teacher training programs be organized and the focus should be on the differentiation between being friendly not a friend and the development of effective communication skills.

Lastly, higher level of mathematics literacy of students whose teachers use cognitive activation strategies at a level above the average showed the importance of teachers' pedagogical content knowledge. In this context, it is recommended to teacher educators that the content of the courses such as "Special Teaching Methods" and "Principle and Practice of Instruction" which aim to develop pedagogical content knowledge should be revised. Furthermore, new elective courses focusing on these issues should be offered.

This study was conducted with PISA 2012 data of Turkey. Using the same variables that were the focus of the present study, further work can be conducted to compare other countries. It is also recommended that researchers design a quasi-experimental study to compare the mathematics literacy and relation of two groups of students with their teachers, one group receiving instruction developing cognitive activation and the other as control group attending the regular lesson as in the MoNE curriculum.

There are several limitations of this study. Firstly, in this study, low correlations among the variables were found. Large sample size may yield in a statistically significant relationship. In other words, a small correlation coefficient would be statistically significant with a larger sample size (Fishman & Galguera, 2003). Therefore, when the practical significance of correlation coefficients found in the present study was considered, these correlation coefficients were concluded to be practically significant since "even small correlations may be practically significant for researchers who are trying to build models of relationships among many variables" (Lodico, Sapulding &Voegtle, 2010, p.284). What is more, although the standardized coefficients were generally small, they are additive; so, if they could all be simultaneously improved, achievement of each student in the classroom could increase much more. Similarly, depending on the fact that standardized path coefficients correspond to effect size (Hoyle, 1995), the effect sizes obtained in this study were concluded to be small. However, in some circumstance "even small effect sizes have a practical significance" (Whitley & Kite, 2013, p.535). These small effects can accumulate over time to bring about large effects. For instance, in this study, as the effects of teaching and learning variables on mathematics literacy increases cumulatively, students' mathematics literacy can increase over the instruction. This situation gains importance as the sample size becomes larger (Whitley & Kite, 2013). When the other countries participating PISA are included, small effects among variables can add up and thus the scores of the students regarding related variables can increase or decrease in larger samples. Secondly, the results of this study pointed to associations among variables. Hence, no conclusions can be drawn on the causal effects. Lastly, in this study, only student level variables were handled. Thus, the effects of teacher and school level variables addressed in teacher and principal questionnaires can be analyzed by performing hierarchical linear modeling analysis.

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