Students' Extrinsic and Intrinsic Motivation Level and Its Relationship with Their Mathematics Achievement

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Abstract

This study focused on the extrinsic and intrinsic motivation levels of eighth grade students and its relationship with their mathematical achievement. The participants of the study included 6829 students who took TIMSS in 2011 and 239 mathematics teachers. The data obtained from the student and teacher questionnaires that are included in the content of TIMSS exam were used. Two-level HLM was used to examine how students' mathematics achievement is related to their extrinsic and intrinsic motivation levels. One way ANOVA with Random effects, Means as Outcomes Regression Model, The Random Coefficient Regression Model were used in the two level HLM. The study results show that students' mathematics interest, self-efficacy, perceptions of mathematics, and the frequency of mathematics exams and teachers' interest in students at schools are related to mathematics achievement. The examination of the effect size of the variables particularly shows that intrinsic motivational variables have a stronger relationship with mathematics achievement than extrinsic motivational variables. The overall analysis of the study findings shows that mathematics achievement is related to both intrinsic and extrinsic motivational resources that need to be addressed by mathematics experts and teachers.

Key Words: Mathematics achievement, TIMSS, motivation, hierarchical linear modeling, extrinsic and intrinsic motivation.

Introduction

Mathematics is a human activity, a social phenomenon, a set of methods used to help illuminate the world and it is part of culture (Boaler, 2008). "Mathematics is the backbone of modern science and a remarkably efficient source of new concepts and tools to understand the "reality" in which we participate. It plays a basic role in the great new theories of physics of the

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XXth century such as general relativity and quantum mechanics" (Connes, 2005, p. 01). "What mathematics offers is a way of doing things: to be able to solve mathematical problems, and more generally, to have the right attitude for problem solving and to be able to confront all kinds of problems in a systematic manner" (National Council for Educational Research and Training, 2006). Children who do learn about the true nature of mathematics are very fortunate and it often shapes their lives. Thus, mathematics is a crucial course for students since mathematical skills are important job skills and useful in everyday life. Betz (1978) stresses that mathematics is one of the most important tools that human beings must possess in order to adapt to the developing and changing world.

According to the American National Research Council's report (1989) expertise in most occupations requires at least a basic knowledge of mathematics and geometry. Tobias (1978) stated that mathematical knowledge is a key factor that increases the chances of employment in recruitment exams done by the army, private, and government institutions. Therefore, one of the primary goals of education should be to make students reach high competence in mathematics (Tall and Razali, 1993). Considering the importance of mathematics for students and individuals, national policy makers, educators, and researchers have been examining factors that may have meaningful and consistent relationships with mathematical achievement. One factor that has received considerable attention is *motivation*. "To be motivated means to be *moved* to do something. A person who feels no impetus or inspiration to act is thus characterized as unmotivated, whereas someone who is energized or activated toward an end is considered motivated" (Ryan and Deci, 2000, p.54). Studies on mathematics show that students should have high motivation in order to achieve a high standard of mathematical education. Students who have high motivation take education more seriously, participate in classroom activities, consider teachers' recommendations, and have higher academic achievement scores (Pajares and Schunk, 2001; Wolters and Rosenthal, 2000). Motivation also makes students display their real potential (Eggen and Kauchak, 1997). Thus, motivating students to be enthusiastically receptive is one of the most important aspects of mathematics instruction.

Motivation is a complex psychological construct that attempts to explain behavior and the effort applied in different activities (Watters and Ginns, 2000). Motivation involves extrinsic rewards that occur outside the learner's control and intrinsic goals in their desire to achieve a particular target. While physical reward, punishment, social pressure, higher social expectations, homework, and classroom competition are items of extrinsic motivation (Moore, 2001), intrinsic motivation includes factors such as attitude, value, needs, and the desire to become competent (Moore, 2001; Pintrich and De Groot, 1990). Intrinsic motivation is regulated by the individual himself. According to Deci (1972), a person is intrinsically motivated to perform an action if there is no apparent incentive except the action itself or the feelings which result from the activity. However, in extrinsic motivation, environment is the central controlling mechanism and the person's motivation is regulated by the outside rewarding mechanisms that s/he considers as a reward (Newstrom and Davis, 2002; Wu, 2003).

In mathematics education, student motivation plays a key role, (Gelman and Greeno, 1989; Hannula, 2006; Middleton and Spanias, 1999; Singh, Granville, and Dika, 2002; Walker and Guzdial, 1999) and mathematical achievement is related to both intrinsic and extrinsic motivational factors. Research has shown that intrinsic motivation leads to self-efficacy (Pajares, 1996) which is a clear predictor of students' academic performance in mathematics (Alliman-Brissett and Turner, 2010; Mousoulides and Philippou, 2005). Intrinsically motivated students are not discouraged by more complex problems (Middleton and Spanias, 1999) and they spend more time on-task, tend to be more persistent, and are confident in using different, or more challenging, strategies to solve mathematical problems (Lepper, 1988; Lepper and Henderlong, 2000). Students who are highly intrinsically motivated to study mathematics increase their achievement, their determination in the face of disappointment, and their confidence (Lehmann, 1986; Pokay and Blumenfeld, 1990). Mathematics courses can be arduous and intrinsic motivation can energize children to invest the effort and utilize the strategies necessary to be successful (Froiland, Oros, Smith, and Hirchert, 2012). In a large scale study using TIMSS data, Mullis et al. (2000) found that students who show positive attitudes toward mathematics and display signs of intrinsic motivation were more likely to get higher scores. Intrinsically motivated students are more likely than their peers to use effective mathematics strategies such as estimating, visualizing, and checking (Montague, 1992). Middleton, Littlefield, and Lehrer (1992) found that students' intrinsic motivation to learn mathematics is highly influenced by the classroom tasks designed by the teacher. The authors conclude that mathematics activities must be difficult enough that students are not bored, yet tasks must allow for a high degree of success given appropriate effort by the student. Similarly, Boaler (1999) reported a relationship between meaningful mathematical tasks and student intrinsic motivation. Accordingly, when given the opportunity to engage in meaningful mathematical tasks that maintain their cognitive integrity, students not only tolerate mathematical work, but express pleasure and satisfaction.

In contrast to the intrinsic motivation which is related to internal rewards, extrinsically motivated students engage in learning for external rewards, such as teacher and peer approval, and good grades (Mueller, Yankelewitz, and Maher, 2012). According to Middleton and Spanias (1999), extrinsically motivated students do not necessarily have a sense of ownership of the mathematics that they study; instead they focus on praise and interest from teachers, parents and peers and avoiding punishment or negative feedback. It is typically believed that intrinsic motivation tends to be deeper and more influential than the extrinsic one and its corresponding effect also continues longer (Zhu and Leung, 2011). Several researchers (e.g., Deci, 1971; Deci, Koestner, and Ryan, 1999; Kruglanski, Friedman, and Zeevi, 1971; Lepper, Greene, and Nisbett, 1973; Lepper and Henderlong, 2000) contend that extrinsic rewards undermine existing intrinsic motivation. According to Zhu and Leung (2011, p. 1191-1192) "the argument about the superiority of intrinsic motivation usually relates to its nature, that is, it originates from within the individual and is independent of external influences. In contrast, researchers viewed the temporariness as one serious drawback of extrinsic motivation, that is to say, such motivation would disappear as soon as the reward or punishment was withdrew." Despite the negative ideas on extrinsic motivation, several researchers argued that extrinsic motivation triggers the intrinsic motivation rather than undermining it and it has positive effects especially when students have low levels of intrinsic motivation (Brophy, 2004; Cameron, 2001; Lepper, Corpus and Lyengar, 2005).

Considering the conflicting arguments on the importance of intrinsic and extrinsic motivation and their relation to mathematics, it is significant to conduct large scale studies that examine these two different motivation types and compare the degree of their relation to mathematics achievement. Hence, this study aims to examine students' intrinsic and extrinsic motivation levels and their relationship with mathematics achievement and handles the following research questions:

1. Does students' mathematics achievement vary according to external resource levels?
2. What are the intrinsic resources that are related to students' mathematics achievement?
3. What are the extrinsic resources that are related to students' mathematics achievement?
4. Which motivation type is more related to students' mathematics achievement?

By providing results from a large group of participants from the Turkish context, it is hoped that the study will contribute to the research that examines and compares intrinsic and extrinsic motivational variables and their relationship with mathematics achievement simultaneously and provide actionable guidelines for researchers and educational practitioners.

Method

Research Model

In this study, the student and teacher characteristics that are related to students' mathematics achievement are determined. Thus, this study follows a relational screening model.

Sample and Population

In this study, Mathematics and Science Study (TIMSS) 2011 data were used. Therefore, the sample and population specified by TIMSS were used. Since the study aims to examine students' intrinsic and extrinsic motivation levels and their relationship with mathematics achievement, it uses TIMSS 2011 student data for intrinsic motivation levels and TIMSS 2011 teacher data for extrinsic motivation levels. In this respect, the population of the study includes eighth grade students enrolled in schools of secondary education in Turkey during the 2011 educational year and mathematics teachers. The sample of the study includes 6826 students who took TIMSS in 2011 and 239 mathematics teachers. The data for the study was obtained from TIMSS web page (http://timss.bc.edu/).

Data Collection Tools

In this study, the data obtained from the student and teacher questionnaires that are included in the content of TIMSS exam were used. TIMSS 2011 student questionnaire has six items on mathematics interest, nine items on self-efficacy, and five items on students' general perceptions of mathematics. Mathematics interest in the student questionnaire includes clauses such as "I enjoy learning mathematics", and "I like mathematics". On the other hand, the self-efficacy section in the TIMSS 2011 student questionnaire has clauses such as "I can easily learn mathematics," and "Mathematics is easier than other courses". The general perceptions of mathematics section include clauses primarily about the use of mathematics in real life. These clauses are; “I think I will use mathematics in my daily life” and “In order to have a job I need to have a sufficient knowledge of mathematics”.

In the teacher questionnaire, the “exam” variable was taken into consideration. In relation to this variable the questionnaire includes the clause “how often do the students have mathematics exams?” Additionally, the questionnaire includes an item on the interest displayed by the teacher for the students. “I explain the answers of the questions” and “I help my students find the best techniques to solve complex questions” clauses are related to this item (Mullis and Martin, 2011).

In TIMSS 2011 mathematics achievement is determined by mathematics achievement tests. The achievement tests generally cover the basic skills that are practiced in education programs. Mathematics achievement test in TIMSS 2011 includes questions about mathematical knowledge, mathematical processes, the ability to use complex mathematical processes, problem solving, problem identifying, and mathematical judgment (Foy, Arora, and Stanco, 2013).

Data Analysis

Two-level HLM was used to examine how students’ mathematics achievement is related to their extrinsic and intrinsic motivation levels.

The Level 1 (student level) involves data from the student questionnaire. The variables “interest”, “self-efficacy”, and “perception” are related to intrinsic motivation. The Level 2 (teacher or classroom level) level involves data from the teacher questionnaire. The variables “exam” and “interest in the student” are related to extrinsic motivation.

The majority of data obtained in social sciences, is nested and has a hierarchical structure (Atar, 2010). Measurement in education focuses on student variables which are achievement, attitude, ability, and proficiency. Student variables can vary according to some factors. These factors can stem from classrooms and schools in which the students have educational experiences (Hox, 1995). In education, research has shown that students are nested in classrooms; classrooms are nested in schools, schools within cities, cities within regions, and regions within countries. Hence, most of the data gathered from studies conducted in social sciences are entwined, and thus, display a hierarchical structure (Hox, 1995; O’Connel and McCoach, 2008; Osborne, 2002; Raudenbush and Bryk, 2002; Snijders and Bosker, 1999). Doing unilevel analysis instead of multilevel analysis for the data which has a hierarchical structure is not suitable, as such an operation will violate the independence of the observations in the data set with other observations in the data set (Hox, 1995). Students cannot be considered distinct from classrooms, classes from schools, schools from districts, and districts from countries. Therefore, using a Hierarchical Linear model for hierarchical data analysis will provide more comprehensive and detailed results (Hox, 2002; O'Connell and McCoach, 2008; Osborne, 2002; Raudenbush and Bryk, 2002; Snijders and Bosker, 1999). This research uses HLM as the data gathered from TIMSS 2011 is entwined and displays a hierarchical structure.

One way ANOVA with Random effects, Means as Outcomes Regression Model, and The Random Coefficient Regression Model are used in two level HLM. As Raudenbush and Bryk, (2002, p.26) put it, "the simplest possible hierarchical linear model is equivalent to a one-way ANOVA with random effects. This model is fully unconditional i.e. no predictors are specified at either level 1 or 2. Means as outcomes regression model demonstrates whether means from each of many groups as an outcome to be predicted by group characteristics. One-way ANOVA and means-as-outcomes sub models were random-intercept models and only the level-1 intercept coefficient, was viewed as random. Regression slopes did not exist in those models. However, a major class of applications of hierarchical linear models conceives level-1 slopes as varying randomly over the population of level-2 units. Random coefficients regression model is the simplest case of this type. In these models, both the level-1 intercept and one or more level-1 slopes vary randomly, but no attempt is made to predict this variation."

While SPSS 17.0 and Microsoft Excel 2010 were used for data organization, HLM 7.0 was used for the hierarchical linear model. The level of the statistics obtained from the study was considered as minimum .05 in the significance test. Table 1 shows the descriptive statistic values related to variables.

Table 1. Descriptive Statistics

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Outcome Variable					
Mat. Achievement	6826	449.97	106.61	142.85	844.40
Explanatory Variable					
Interest, γ_{10}	6826	18.45	4.36	.00	24.00
Self-Efficacy, γ_{20}	6826	20.28	4.66	.00	32.00
Perception, γ_{30}	6826	14.77	3.74	5.00	20.00

Exam, γ_{01}	239	3.25	.68	2.00	5.00
Interest in student, γ_{02}	239	34.45	5.87	.00	44.00

Findings

Two-level HLM was used to examine how students' mathematics achievement is related to their extrinsic and intrinsic motivation levels. One way ANOVA with Random Effects, Means as Outcomes Regression Model, and The Random Coefficient Regression Model were used respectively in HLM.

Table 2 displays the correlation values between the outcome variable and the explanatory variables that show the intrinsic motivation levels at the student level.

Table 2. The correlation values between the outcome variable and the explanatory variables

	Interest	*Self-Efficacy*	*Perception*	*Achievement*
Interest				
Self-Efficacy	.62*			
Perception	.55*	.48*		
Achievement	.32*	.48*	.21*	
	Exam	*Interest in student*		*Achievement*
Exam				
Interest in student	.05*			
Achievement	.08*	.10*		

*p<.01

Table 2 displays the correlation values between the variables at the student level (intrinsic motivation level). The correlation between explanatory variables is higher than the correlation between the outcome variable and the explanatory variables. On the other hand, the relationship between the variables at the classroom level (extrinsic motivation level) is low. There is a low but significant relationship between the variables at the classroom level (extrinsic motivation level) and the outcome variable.

Equations formed in HLM and the findings are as follows:

Level 1 Model

$MAT_{ij} = \beta_{0j} + \beta_{1j}*(Interest_{ij}) + \beta_{2j}*(\text{self-efficacy}_{ij}) + \beta_{3j}*(Perception_{ij}) + r_{ij}$

Level 2 Model

$\beta_{0j} = \gamma_{00} + \gamma_{01}*(Exam_j) + \gamma_{02}*(\text{Interest in student}_j) + u_{0j}$

Table 3. HLM results of the students' Mathematics achievement

Parameter	One Way ANOVA			Level 1 Model				Level 2 Model			
Fixed effects	Coefficient	Standart Error	t-ratio	Coefficient	Standart Error	t-ratio	Effect Size	Coefficient	Standart Error	t-ratio	Effect Size
Level 1											
Intercept, γ_{00}	450.39	4.16*	108.32	450.42	4.16*	108.31		450.41	4.09*	110.12	
Interest, γ_{10}	-	-		1.99	.33*	5.98	.36				
Self-Efficacy, γ_{20}	-	-		9.77	.34*	28.90	.88				
Perception, γ_{30}	-	-		1.54	.33*	4.61	.28				
Level 2											
Exam, γ_{01}	-	-						12.30	6.09**	2.01	.13
Interest in student, γ_{02}	-	-						2.92	1.27**	2.30	.15
Random effects	Standart Deviation	Var.Com.***	χ^2	Standart Deviation	Var.Com.	χ^2		Standart Deviation	Var.Com.	χ^2	Relability estimate
Intercept, u_0	61.96	3838.82	3521.48*	62.67	3929.78	4859.36*		60.87	3705.56	3367.82*	.95
Interest, u_{1j}				2.35	5.50	317.73*					.19
Efficacy, u_{2j}				3.18	10.12	378.99*					.35
Perception, u_{3j}				177.54	3.15	274.21**					.11
Level 1, r	87.60	7674.04		72.94	5320.13			87.60	7674.14		

[1]Before the analysis the classroom level variables (extrinsic motivation level variables) were centered around the grand mean, student level variables (intrinsic motivation level variables) were centered around the group mean.

*$p < .01$. ** $p < .05$.

***Var.Com.=variance component

According to the one way ANOVA with random effects in Table 3, the mean mathematics achievement for all classes was estimated as t= 108.32 with the ratio γ_{00}= 450.39. These results show that the fixed parameters are significant (χ^2=3521.48, df=238, p<.01). Thus, mathematics achievement displays a significant difference among classes according to the external resources.

95% confidence interval for the mean mathematics achievement is as follows:

Confidence Interval= 108.32 ± 1.96 (.91)

$(107.41 \leq \gamma_{00} \leq 109.23)$

The one-way ANOVA random effects model splits the total variance that belongs to the mathematics achievement score into two components. These components are the variance among students in classrooms (Level-1) and the variance among the classrooms (Level-2). These components are demonstrated as follows:

$$\sigma^2 / (\sigma^2 + \tau_\beta) = 7674.04/ (7674.04+ 3838.82) = .67$$

$$\tau_{00} / (\sigma^2 + \tau_{00}) = 3838.82/ (3838.82+ 7674.04) = .33$$

According to these results, while 67% of the total variance stems from the difference among students' intrinsic motivation levels, 33% is caused by the difference between the extrinsic motivation levels. The value .33 also shows the correlation coefficient (p) within the classrooms (extrinsic motivation level).

The random coefficient regression model (model 1) findings on Table 3 show that variables that belong to students' intrinsic motivation level (interest, self-efficacy, and perception) are related to their mathematics achievement.

The coefficient values that belong to the mathematics interest variable shows that there is a positive significant relationship between mathematics interest and mathematics achievement (γ_{01}=1.99, SE=.33, p<.01). Thus, students who show interest in mathematics are better achievers. There is also a positive significant relationship between self-efficacy and mathematics achievement (γ_{02}=9.77, SE=.34, p<.01). Accordingly, the students who think they have sufficient potential to learn mathematics have higher mathematics scores. The study results display that there is a positive significant relationship between students' perceptions of mathematics and mathematics achievement scores (γ_{03}=1.54, SE=.33, p<.01). In this sense, students who have positive perceptions about mathematics course have higher achievement scores than the students who have negative perceptions. In other words, the students who think that mathematics is useful for daily life experiences have high mathematics scores.

Of the three variables of intrinsic motivation, the one that has the highest relationship with mathematics achievement is the self-efficacy variable. Compared to other intrinsic motivation variables, the perception of mathematics variable has a lower relationship with mathematics achievement. Additionally, 31% of the student achievement within the classroom can be described by the intrinsic motivation variables (student level variables).

In level two "the frequency of exams in mathematics courses" and "the interest shown by the teacher to the student" were considered for the students' extrinsic motivation. The relationship between these variables and mathematics achievement was examined. The study results show that there is a positive significant relationship between the frequency of exams and mathematics achievement (γ_{01}=12.30, SE=6.09, p<.05). Thus, as the teacher increases the number of mathematics exams, the students' mathematics scores also increase. The study results also display a significant relationship between teacher's interest shown to the student and mathematics achievement (γ_{02}=2.92, SE=1.27, p<.05). Furthermore, 3% of the classroom means variance can be described by the extrinsic motivation level variables (classroom level variables).

The reliability values of the variables in Table 3 show that the reliability value that belongs to the fixed is high (.95). This result indicates that $\hat{\beta}_{0j,}$ the mean mathematics achievement in the classrooms (extrinsic motivation level), is a reliable predictor.

Of the level one explanatory variables self-efficacy variable (*self-efficacy*, γ_2=.35) has the highest reliability. Self-efficacy is followed by the mathematics interest variable (Interest, γ_1=.19). Perception variable has the lowest reliability value (*Perception*, γ_3=.11). The reliability predictions being more than .05 show that these coefficients vary randomly among classrooms.

When the effect size of the variables are examined, the variable that has the highest relationship with mathematics achievement is self-efficacy (effect size=.88), followed by interest (effect size=.36), perception (effect size=.28), interest in student (effect size=.15), and exam (effect size=.13). These results display that intrinsic motivational variables have higher effect sizes than the extrinsic motivation variables.

CONCLUSION AND DISCUSSION

In the HLM conducted, initially the three variables of intrinsic motivation and subsequently two variables of extrinsic motivation were included in the model. The study results show that all the variables of the intrinsic motivation and extrinsic motivation are related to students' mathematics achievement. However, a comparison between the variables of extrinsic and intrinsic motivation shows that the relationship between intrinsic motivational factors and mathematical achievement is higher than the extrinsic ones. This finding corresponds with the research findings that stress the superiority of intrinsic motivation over extrinsic motivation in mathematics achievement (Zhu and Leung, 2011). In this sense, this finding strengthens the argument that mathematics education should aim to increase students' intrinsic motivation in order to help students achieve success in mathematics. Increasing intrinsic motivational levels of student is an intricate process that assigns different roles to parents, teachers, and educational policy makers. According to Davidson et al. (2007) interesting and challenging activities that are personally meaningful help to cultivate intrinsic motivation. Inquiry based learning that integrates group work and discovery also assists intrinsic motivation. Intrinsic motivation is affected by adults, including parents, teachers, and other adults with whom the student has a connection. Parents with high expectations but a positive attitude tend to have more intrinsically motivated children. A considerate and respectful teacher student relationship can foster intrinsic motivation. Having a choice of positive extracurricular activities also improves motivation in the classroom. Behavior of school administrators can also influence teacher motivation, which in turn can influence student motivation; when teachers feel that they have a voice in decision making they feel more motivated.

A noteworthy finding of the study is the relationship between self-efficacy and mathematics achievement. The literature on mathematics and self-efficacy provides parallel findings (Alliman-Brissett and Turner, 2010; Bourquin, 1999; Lane and Lane, 2001; Migray, 2002; Mousoulides and Philippou, 2005; Otunuku and Brown, 2007; Pietsch, Walker, and Chapman, 2003; Stevens, Olivarez, and Hamman, 2006; Wilkins, 2004; Zimmerman, 2000) and self-efficacy is often regarded as a byproduct of intrinsic motivation (Pajares, 1996). These study results show that the students who think they have enough potential to cope with mathematics have higher mathematics scores than the students who do not feel any potential to learn mathematics. This variable also has the highest relationship with mathematical achievement. Thus, students who think that they have no mathematical potential should be motivated and supported to discover their underlying potential.

According to the study results, the students who are interested in mathematics have better test scores. Similarly, Singh, Granville, and Dika (2002), Shin, Lee, and Kim (2009), and Cai-zhen (2008) found a high correlation between mathematical interest and mathematical performance. In another study, Bayturan (2004) found that students who are interested in mathematics enjoy mathematics classes, participate in mathematics classroom activities, consider being successful in mathematics as crucial, and find the mathematics courses interesting. Conversely, students who are not interested in mathematics had lower scores and displayed none of these features. These results show that it is important for teachers to recognize their students and have an awareness of their mathematical interests. As Osborne, Simon, and Collins (2003) stated teachers should use suitable activities for their classes and students so that students who are not interested in the subject matter and who have negative attitudes can display positive transformations. In addition to teachers, families also have key roles in increasing students' interest rates about various subjects (Kawiak, 2013). Therefore, both teachers and parents should cooperate to increase students' interest levels (Rice et al., 2013).

The study findings reveal that students who think mathematics is useful for their daily life activities have better mathematical test scores than the students who consider mathematics unnecessary for daily life. According to Schiefele and Csikszentmihalyi (1995) and Singh, Granville, and Dika (2002) students' perceptions about a course has a relationship with their achievement scores. Marsh, Craven, and Debus (1999) demonstrated that cognitive and affective self-perceptions were highly correlated. Boaler (1999) also reported that when students engage in meaningful mathematical tasks that they can relate to real life experiences, they find mathematics an enjoyable subject to study. On the other hand, Akyüz and Satıcı (2013) claim that students' mathematics perceptions and mathematics achievement have a negative relationship. Correspondingly, in this study mathematics perception has the lowest correlation with mathematic achievement. In this sense, further research which examines reasons for the relationship between mathematics perception and achievement should be conducted.

According to the study results there is a relationship between the interest shown by the teacher to the student and mathematical achievement. Similarly, according to Program for International Student Assessment (PISA) 2000 results the disciplinary climate and teacher's interest have an influence on students' performance (Organisation for Economic Co-operation and Development-OECD, 2001). Osseiran-Waines and Almacian (1994), Cutrona, Cole, Colangelo, Assouline, and Russell (1994), Levitt, Guacci-Franco, and Levitt (1994), and Meeus (1993) reveal a relationship between teacher's support and academic achievement. According to Ladd (1990) students who are supported by their families and teachers can adapt to schools easily and have higher tests scores. On the contrary, Bos and Kuiper (1999) found class climate and teacher's interest did not show significant relationships with mathematical achievement in the most of the models of European countries. Although there are contradictory findings on teacher's interest and student achievement the studies in general show that teacher's and families' interest can be important not only for academic achievement but also for student adaptation and devotion.

The study results also display a relationship between exam frequency and mathematical achievement. Amrai, Mothlag, Zalani, and Parhon (2011) argue that extrinsic motivation variables such as exam and grading are related to academic achievement in general. In a study Akyüz (2006) found that the relationship between mathematical literacy and exam frequency varies from country to country. For instance, in Hungary, Lithuania, and Holland students had lower mathematics achievement scores as the number of the exams increased. Conversely, Turkish students had higher scores if they were exposed to mathematics exams more frequently. Although exams are frequently used to increase the external motivation of the students, it should be kept in mind that having low scores from these exams may demoralize the students and have negative effects.

The overall analysis of the study findings shows that mathematical achievement is related to both intrinsic and extrinsic motivational resources that need to be considered by mathematics practitioners, educators, and policy makers. However, the examination of the effect size of the variables particularly shows that intrinsic motivational factors have a higher relationship with mathematical achievement than extrinsic motivational factors. Hence, activities and regulations should be put into practice in order to intrinsically motivate the students who have low or no motivation so that mathematical achievement can be ensured. Stipek et al. (1998) pointed out that in order to increase intrinsic motivation, teachers should use positive verbal feedback, focus on deep understanding rather than performance goals, provide multiple ways of finding solutions and support risk-taking when problem-solving rather than chastising children for getting the problem wrong. As Froiland, Oros, Smith, and Hirchert (2012, p.94) state, "both math reform experts and motivational experts are calling for teachers to use an autonomy supportive style of instruction. In accordance, school psychologists can consult with teachers to show them how to adopt an autonomy supportive teaching style in the mathematics classroom".

It is important to note that the current study is limited to the Turkish context and the findings need to be considered within the scope of Turkey. However, this study can provide the potential for comparative examinations with results coming from different countries. Another limitation of the study is its focus on only the TIMSS data. Hence, other large scale data such as PISA could be examined in order to see how motivational factors are related to mathematics achievement.

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