

# Determination of the Relationship between 8th Grade Students Learning Styles and TIMSS Mathematics Achievement

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## Abstract

In this study, it is aimed to determination of the relationship between learning styles and TIMSS mathematics achievements of eight grade students. Correlational research design that is one of the quantitative research methods, was used in this study. The sample of the research consists of 652 8th grade students 347 are male and 305 are female and the students continue their education in 11 different middle schools in the centre of Bayburt in Turkey. In the research, two data collection tools were used. The first tool is Perceptual Learning Style Preference Questionnaire (PLSPQ) that was developed by Reid (1987) and translated by Bengiç (2008) into Turkish. The second tool is 45-questions achievement test that selected from TIMSS 2011 mathematics questions according to experts' opinions. Frequency, percentage, average, standard deviation, ANOVA and correlation analysis were applied through SPSS for data analysis. The most dominant learning style of the students is auditory and the second one is kinaesthetic learning style. Students' general TIMSS scores vary between 11 and 94 and the average TIMSS achievement score is 43.38. Additionally, it was seen that there is no significant relationship between TIMSS mathematics achievement and learning styles.

**Keywords:** Learning styles, mathematics, TIMSS exam

## 8. Sınıf Öğrencilerinin Öğrenme Stilleri ve TIMSS Matematik Başarıları Arasındaki İlişkinin Belirlenmesi

### Özet

Bu çalışmanın amacı sekizinci sınıf öğrencilerinin öğrenme stilleri ile TIMSS matematik başarıları aralarındaki ilişkiyi belirlemektir. Çalışmada nicel araştırma yöntemleri içerisinde yer alan ilişkisel araştırma yöntemi kullanılmıştır. Araştırmanın örneklemini, Bayburt merkezde 11 farklı orta okulda öğrenim gören 347'si erkek, 305'i kız olmak üzere 652 sekizinci sınıf öğrencisinden oluşmaktadır. Araştırmada iki veri toplama aracı kullanılmıştır. İlk veri toplama aracı Reid (1987) tarafından geliştirilen ve Bengiç (2008) tarafından Türkçe'ye çevrilen Algısal Öğrenme Stili Envanteridir. İkinci veri toplama aracı, açıklanan TIMSS 2011 matematik soruları arasından seçilen ve uzman görüşleri doğrultusunda oluşturulan 45 soruluk başarı testidir. Verilere SPSS programında frekans, yüzde, ortalama, standart sapma, ANOVA ve korelasyon analizleri uygulanmıştır. Analizler sonucunda öğrencilerin baskın olarak işitsel, ikinci sırada ise kinestetik öğrenme stiline sahip oldukları görülmüştür. Öğrencilerin genel TIMSS başarı puanları 11 ile 94 arasındadır ve ortalama TIMSS başarı puanı 43.38'dir. Ayrıca öğrencilerin sahip oldukları öğrenme stilleri ile TIMSS matematik başarıları arasında anlamlı bir ilişki olmadığı tespit edilmiştir.

**Anahtar Kelimeler:** Öğrenme stilleri, matematik, TIMSS sınavı

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## 1. Introduction

During learning process, each learner has a specific learning style. Kolb (1985) defined leaning style as method or way chosen by the students during learning process. Dunn & Dunn (1993) clarified that learning style is unique for each individual like a fingerprint and it is a specific way learning. Every individual uses their own learning styles while learning new or complicated information in order to internalize and remember them. Also, a vast number of researchers proved that learning styles were an individual's signature approach to learning and they can provide important contributions to select and organize learning conditions by means of scientific methods (Dunn, Beudury & Klavas, 1989).

Jonassen & Grobowski (1993) explained that learning styles consist of the learner's preferences in different educational and instructional activities. These general tendencies are preferred in processing data in different ways. According to Honey & Mumford (1992) learning style is an individual approach and some students can prefer one of these learning tendencies but the others can prefer the others. Dunn & Dunn (1993) express that every student use their own fingerprint while learning new and difficult information and remembering them. Legendre & Legendre (1998) defined that learning style is the person's way of learning, solving a problem, thinking and reacting style during education. Besides; learning styles are the features which we have had since the birth and they affect the individual during walking, sleeping, sitting, speaking, playing and writing and she/he does the activities according to them (Boydak, 2001; Metin, Kaleli-Yılmaz, Birişçi & Coşkun, 2011:590).

Determining students' learning styles is highly important for the learning and teaching processes. After determining learning style of students, surely teachers will be fairly advantageous in choosing better instructional methods, techniques, strategies and materials (Aşkar & Akkoyunlu, 1993; Peker & Aydın, 2003). In fact, teachers cannot design specific learning conditions for every student but they may have opportunities to design learning conditions which reflect the dominant learning style in the class. It is commonly known that when students meet educational activities which are appropriate for their learning styles, they learn easier and faster than the students who do not learn in similar ways (Tatar & Tatar, 2007). Thus, one of the important factors of students' failure is that not providing appropriate learning styles to them and not performing education-training activities which are designed according to appropriate learning styles (Mutlu & Aydoğdu, 2003).

Exams such as "Trends in International Mathematics and Science Study" (TIMSS), "Program for International Student Assessment" (PISA) and "The Progress in International Reading Literacy Study" (PIRLS) have an effect on determining students' achievement and achievement of education systems of countries. In general, Turkish students obtain low scores in these exams. In this respect, recently, a number of researchers have focused on underlying reasons of this failure in Turkey (Kablan & Kaya, 2013; Hanci, 2015; Kaleli-Yılmaz & Hanci, 2015). However, especially

these studies in mathematics are quite limited. In this respect, the current research aimed to determine the relationship between TIMSS Mathematics achievement and learning styles. In the following sections, more detailed information about TIMSS exam was presented.

### 1.1. Main Models for Learning Styles

Related literatures indicate that various models were developed to determine learning styles. Most frequently used models are the Dunn and Dunn learning style (Dunn & Dunn, 1993), Riechmann & Grasha learning Style (Riechmann & Grasha, 1974), Gregorc learning style (Gregorc, 1979), Kolb's learning style (Kolb, 1984), McCarthy learning Style (McCarthy, 1987) and Reid's learning style (Reid, 1987). Each learning style model is focused on different dimensions because every model is different from one another. Reid's learning style scale is easy to understand and administer and this scale has clear and understandable questions for 8<sup>th</sup> grade students. Therefore this scale was used to acquire data in this study. Learning style scale of Reid consists of six learning styles: Audial, Visual, Tactile, Kinaesthetic, Individual and Group learning styles.

*Auditory Learning Style Preference:* Auditory learners tend to remember what they hear (Landy, 2005). The students with that learning style can remember and call back the information they learned by hearing better and quicker than another information that was learned by other sensory mechanisms.

*Visual Learning Style Preference:* The students who have visual learning style enjoy with tables, shapes, figures, schemes, graphics, designs and pictures. They can observe easily and they can draw what they imagine easily. They often use jests and mimics, and nod. They do not forget what they saw (Tabanlıoğlu, 2003).

*Tactile Learning Style Preference:* Tactile learners remember things they drew, wrote, made by hand and touched (Landy, 2005). Eye-hand coordination is well-developed. They are superior to call back the things they felt by their tactual senses.

*Kinesthetic Learning Style Preference:* Kinesthetic learners prefer to take action rather than talking (Murray, 2004). These students are successfully remember what they have learned before and by participating actively in the role-playing studies in the class (Reid, 1998).

*Individual Learning Style Preference:* Students who have individual learning styles can efficiently learn by themselves. They prefer to learn by being alone. They like to take individual responsibility. They think that they can be more successfully when they work by themselves (Chen, 2006).

*Group Learning Style Preference:* They can work with others very well. They have problems to focus and concentrate by themselves. Students who have this learning style can be very successful when they perform group work or team work (Chen, 2006).

## **1.2. Literature Review on Research on Learning Styles**

Aslan & Babadoğan (2005) have used Kolb's learning style inventories in order to determine the relationship between the achievement and learning styles of 7th and 8th grades students in their studies. As a result of the study, it is identified that there is a relationship among Mathematics, Turkish, science lesson's achievement and their learning styles. Besides, it is seen that there is no significant relationship between gender and learning styles. Yenilmez & Çakır (2005) have investigated the relationship between secondary school students' mathematics learning styles and demographic variables. As a result of this study, it is confirmed that there are differences between gender, class level and learning styles according to their maths mark in school reports. In addition to this, it is seen that maths learning styles have not differentiated according to parents' education levels. Yılmaz-Soylu & Akkoyunlu (2009) have used Kolb's learning styles inventories and investigated students' academic achievement. As a result of the study, it is investigated that students' learning styles have no effects on their achievement in different learning environments. Abidin, Rezaee, Abdullah & Singh (2011) have used Reid's Perceptual Learning Style Preference Questionnaire in their study. As a result, they determined that students have more than one learning styles and these students have showed more academic achievement. Metin, Kaleli-Yılmaz, Birişçi & Coşkun (2011) have used Kolb's learning style inventory in their study which they investigated students' learning styles in terms of grade level, type of school, graduation type of mother and father. As a result of the study, it is investigated that dominant learning style is accommodator. Besides, it is seen that some learning styles differ according to variables. Finally Ergin & Sarı (2015) have examined the relationship between students' learning styles and their achievement according to 4mats learning and expository teaching method. As a result of the study, remarkable differences cannot be found between students' learning styles and their test marks in both methods. However, it is confirmed that students having lessons according to 4maths method have improved their achievement in all types of learning styles in a significant rate.

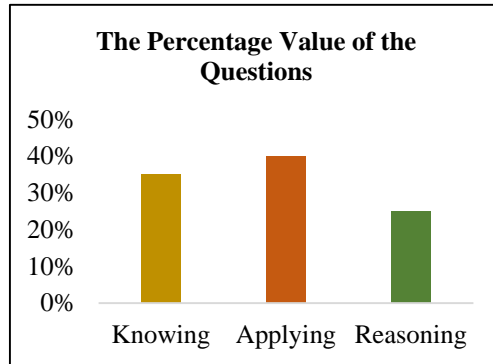
Above there are some searches about learning styles. Except these, there are lots of learning styles studies in literature. Some of them are learning styles scale developing (Reid, 1987; Dunn & Dunn, 1993; Grasha & Riechmann, 1974; Gregorc, 1979; Kolb, 1984; McCarthy, 1987; Otrar, Gülten & Özkan, 2012; Gülbahar & Alper, 2014) and the others are adapting learning styles scale in a different language (Aşkar & Akkoyunlu, 1993; Ekici, 2002; Sarıtaş & Süral, 2010; Akgün, Küçük, Çukurbaşı & Tonbuloğlu, 2014). Nevertheless, it draws attention that there are lots of studies investigating the relationship between learning styles and gender in literature. Among these, some studies present significant differences between learning styles and gender (Matthews, 1996; Fox & Ronkowski, 1997; Güven, 2004; Garland & Martin, 2005; Güven & Kürüm, 2007) some studies present no differences between them (Magolda, 1989; Numanoğlu & Şen, 2007; Ateş & Altun, 2008). Besides, there are some studies presenting meaningful differences between class levels and learning styles (Matthews,

1996; Metin et al., 2011). Although there are a lot of studies investigating the relationship between learning styles and academic achievement, there is limited edition study especially investigating TIMSS maths achievement and learning styles (Zanini & Benton, 2015). That kind of study is done hoping that it will have a significant contribution on literature and widen new horizons.

### 1.3. Trends in International Mathematics and Science Study (TIMSS)

TIMSS exam was first applied in 1995 and organized by International Association for the Evaluation of Educational Achievement's (IEA), and continued to be applied within four years periods. The survey of research evaluates students' gained knowledge and skills in Mathematics and Science lessons at the level of 4th and 8th grades (EARGED, 2011). The main objective of TIMSS project is to collect comparative data about different countries' educational systems with the purpose of developing the education and training on mathematics and science (Mullis, Martin and Foy, 2008).

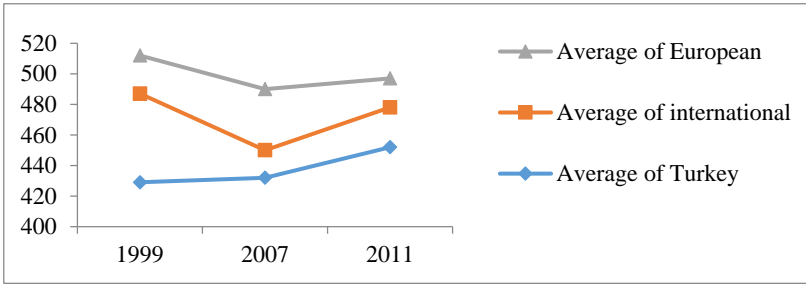
The exam is applied through different sessions. 20-25 questions are posed in every session. While, 36 minutes are given to 4th grade students to answers the questions in each session, 8th grade students are given 45 minutes. Besides, questions about three cognitive domains as knowing, applying and reasoning are addressed in TIMSS 2011 8th mathematics exam. The percentage values of those cognitive domains were given in Figure 1.



**Figure 1.** Question types percentages (Büyüköztürk, Çakan, Tan & Atar, 2014)

According to Figure 1, 35% of questions in TIMSS 2011 examination is “knowing”, 40% of questions is “applying” and 25% is “reasoning”.

Turkey has participated in the TIMSS exams in 1999, 2007 and 2011 before 2015. On Figure 2, International, Turkey's and European TIMSS Mathematics average scores according to years were given.



**Figure 2.** Average of Turkey, European and International (Yücel, Karadağ & Turan, 2013)

Above the figure demonstrates that Turkey failed because of that its scores are lower than both international and European average score. Mullis et al., (2008) emphasised that TIMSS exam results especially the cognitive question correct answering rates of the students from Turkey are quite low. Macnab (2000) stated that the countries having the low scores and rates in the international exams like TIMSS, decided to revise and reform their education systems. So, Turkey has to make serial reforms on its education system. For this reason, determining the reasons and factors that affected students' achievement have the highest importance. Bouhlila (2011) emphasized that there are many factors affecting the students' TIMSS achievement. Kablan and Kaya (2013) state that students' learning styles may be related with their TIMSS achievement. In this context, it is aimed to find out the type of relation between students' learning styles and their TIMSS mathematics achievement.

#### 1.4. The Aim of the Research

Primarily, the aim of the present research is to determine the relationship between learning styles and TIMMS Mathematics Achievement of 8<sup>th</sup> grade students. Within the context of the main purpose, the following research questions are discussed:

- Which learning styles do 8<sup>th</sup> grade students possess according to the Perceptual Learning Style Preference Questionnaire (PLSPQ) developed by Reid?
- What is the achievement rate of eight grade students in TIMSS math test?
- Is there any relationship between 8<sup>th</sup> grade students' learning styles and their mathematics achievement in TIMSS?

#### 1.5. The Significance of the Current Research

As commonly believed, on the international exams such as TIMMS and PISA, students from Far East countries as Hong Kong, Japan, Korea etc., tend to show high performance. Pang (2009) stated that in the most of East Asian countries, teacher dominant, content-specific and exam-centric Mathematics education was carried out. Education is performed with fewer students in the larger classes. Indeed, these countries show high performance in the international and comparative research as TIMMS. In this case, the question is how this achievement is achieved. For finding

the answer of this question searching the relationship between learning styles and mathematics achievement have a significant role. Especially, determining how the Far East students who have outstanding achievement on Mathematics learning can give important tips (Ma, Jong & Yuan, 2013). Ma & Ma (2014), searched the relationship between learning styles and mathematics performances of middle school students in USA, Hong Kong, Japan and Korea by using PISA 2013 data. At the end of the study it was determined that there is a positive relationship between competitive learning style and mathematics performance.

An increase was observed on Mathematics performance of Far East students who used cooperative learning style, but there is no important increase on USA students. In fact, learners do not learn well with unsuitable learning styles and this may be the cause of that result. Concordantly, within the scope of this research. It was aimed to determine the available relationship between TIMSS mathematics achievement and learning styles, and it was thought that learning styles have an effect on Mathematics achievement.

## **2. Material and Methods**

### **2.1. Design of the Research**

In this study, correlational research design (one of the quantitative research methods) was used. Correlational research design shows the linear relationship between two or more variables (Creswell, 2005). Also, this research was used this design, the relationship between learning styles and TIMSS mathematics achievement can be determined.

### **2.2. Sample of the Research**

Easily accessible sampling method is preferred in this research. This study is carried on with 8<sup>th</sup> grade students in Bayburt city in Turkey. Totally 652 of 8<sup>th</sup> grade students have participated in this study. 347 of the students are boys and 305 of them are girls. Each of them is government school students. This study is aimed to investigate students' TIMSS maths achievement or their learning styles according to their demographic information. In order to avoid any ethical problems, the formal permission was got from provincial directorate for national education for the students' participation in research.

### **2.3. Instruments**

In this study, two different data collection tools were used. First one is "Perceptual Learning Style Preference Questionnaire" (PLSPQ) developed by Reid (1987). PLSPQ was used to determine the dominant learning styles of 8th grade students. This scale includes 30 items and each of them has 5 options: "Completely Agree", "Agree", "Not sure", "Disagree", "Completely Disagree". PLSPQ consists of 6 learning styles: Visual, Auditory, Tactile, Kinesthetic, Individual and Group learning styles. That questionnaire's adaptation to Turkish and the validity and reliability studies were

performed by Bengiç (2008). As a result of analysis, Cronbach alpha reliability coefficient is 0.73. If the alpha coefficient of a survey is between  $0.00 \leq \alpha < 0.40$ , questionnaire is not reliable. If it is between  $0.40 \leq \alpha < 0.60$ , questionnaire has low reliability. If, it is between  $0.60 \leq \alpha < 0.80$ , questionnaire is quite reliable. And if the alpha coefficient of a survey is between  $0.80 \leq \alpha < 1.00$ , this questionnaire is reliable at high precision (Kalaycı, 2005:405). In this context, it can be said that the survey conducted in this study is quite reliable. PLSPQ was presented in Appendix-1.

Scoring Sheet		
Visual	Tactile	Auditory
6 ----	11 ----	1 ----
10 ----	14 ----	7 ----
12 ----	16 ----	9 ----
24 ----	22 ----	17 ----
29 ----	25 ----	20 ----
Total ---- × 2 =	Total ---- × 2 =	Total ---- × 2 =
Score	Score	Score
Kinaesthetic	Individual	Group
2 ----	13 ----	3 ----
8 ----	18 ----	4 ----
15 ----	27 ----	5 ----
19 ----	28 ----	21 ----
26 ----	30 ----	23 ----
Total ---- × 2 =	Total ---- × 2 =	Total ---- × 2 =
Score	Score	Score

Figure 3. Learning style scoring sheet (Tabanlıoğlu, 2003)

Scoring sheet given at Figure 3 was used depending on Reid's PLSPQ scoring. According to this scoring sheet, the learning style was taken the highest score by a student is regarded as the student's dominant learning style.

The second data collection tool is TIMSS mathematics achievement test. The test comprises of 45 mathematics questions selected from released TIMSS 2011 8th mathematics exam (TIMSS 2011 Assessment, 2013). When TIMSS 2011 exam were evaluated, the following results were found: 1) TIMSS exams were doing in two sessions. 2) There are 20-25 questions in every session. 3) Exam total time interval is 45 minutes. As it was emphasized before, 35% of questions in TIMSS 2011 is the "knowing component", 40% of questions is on the "applying component" and the rest with 25% of the questions is the "reasoning component". Thus, TIMSS exam was adapted to the study. Then the instrument was divided into two sessions. The first session included 25 questions and the second session had 20 questions. The number of items was determined according to percentages in Figure 1. The number of items of knowing, applying and reasoning components in TIMSS first and second session were showed in Table 1.



Table 1.

*Number of Questions according to Cognitive Domain of TIMSS Exams*

The Exams	Cognitive Domains			Total
	Knowing	Applying	Reasoning	
25-Questions Test	$25*35\%=8.75 \sim 9$	$25*40\%=10$	$25*25\%=6.25 \sim 6$	25
20-Questions Test	$20*35\%=7$	$20*40\%=8$	$20*25\%=5$	20

In this case, as is seen in the Table 1, the first session consisted of 25 questions; 9 items for “knowing component” (1, 5, 7, 9, 10, 13, 18, 21 and 24), 10 items for “applying component” (3, 4, 6, 8, 12, 15, 20, 22, 23 and 25) and 6 items for “reasoning component” (2, 11, 14, 16, 17 and 19).

The second session of TIMSS consisted with 20 items; 7 items for “knowing level” (8, 10, 12, 14, 18, 19 and 20), 8 items for “applying level” (2, 3, 5, 6, 11, 13, 15 and 16) and 5 items for “reasoning level” (1, 4, 7, 9 and 17). Examples of first and second sessions’ questions were provided at Appendix 2. To enable robust and accurate scoring and evaluation, only multiple-choice or filling the blanks questions have been selected from 2011 released 8th grade’s TIMSS mathematic questions.

Selected questions were prepared by TIMSS authorities and superior academics and the final version of that achievement exam questions was prepared due to their suggestions. Research was formed relying on the data obtained from TIMSS exams and PLSPQ results.

## 2.4. Data Analysis

Qualitative and quantitative analysis methods are taken advantages for data analysing in this study. Firstly, calculating TIMSS maths achievement is explained. As is stressed above part, TIMSS exam was applied in two different sessions and first session 25, second session 20 questions were asked. In the first session as there were 25 questions, each answer was 4 points, totally 100 points. In the second session as there were 20 questions, each answer was 5 points, totally 100 points. Each student’s TIMSS maths achievement was calculated in averaging students’ first and second session maths points.

For example if a student answered 15 questions in TIMSS first session and 10 questions in TIMSS second session, he got  $15*4=60$  points for the first session and  $10*5=50$  points for the second session. In that case student’s total TIMSS point was  $(60+50)/2=55$  points. A student’s TIMSS point was calculated as an example and given in the finding part.

While determining dominant learning styles of the students, firstly every single answer of each student’s PLSPQ’s point was calculated and found out the total points. The points of questions were determined according to students’ answers. This grading was done like that “Completely Agree: 5 score”, “Agree: 4 score”, “Not sure: 3 score”, “Disagree: 2 score”, “Completely Disagree: 1 score”. If they chose ‘Disagree’ option, it was 2 points. If they chose ‘Agree’ option, it was 4 points. After point of each option was determined, using Scoring Sheet the points were written just opposite of the

related options in Figure 3. After adding all points, points were multiplied with 2 and student's points from each learning styles were calculated. The learning style which student could get the highest point was discussed as the most dominant learning style. In this case, frequency, percentage, average, standard deviation, ANOVA and correlation tests were applied to TIMSS average score and dominant learning style data by means of SPSS statistical program.

### 3. Results

The findings obtained from the study were presented in this section.

#### 3.1. 8th Grade Students' Dominant Learning Styles Due to Reid's PLSPQ

Depending on the data that was obtained via Reid's PLSPQ (1987), students' dominant learning styles were determined frequency and percentage of students' learning styles are demonstrated in Table 2 below.

Table 2.

*The Students' Dominant Learning Styles*

Learning Style	Frequency	Percent
Auditory	152	23.3
Kinaesthetic	148	22.7
Tactile	111	17.0
Visual	88	13.5
Individual	79	12.1
Group	74	11.3
Total	652	100.0

As was be seen on Table 2, 152 (23.3%) of the students' dominant learning style is auditory, 148 (22.7%) of their dominant learning style is kinaesthetic, 111 (17%) of their dominant learning style is tactile, 88 (13.5%) of their dominant learning style is visual, 79 (12.1%) of their dominant learning style is individual, 74 (11.3%) of their dominant learning style is group learning. According to these findings, the most dominant learning style of the student is auditory and the second one is kinaesthetic.

#### 3.2. 8th Grade Students' TIMSS Mathematics Achievement

The values of general TIMSS scores were calculated by considering the average of the scores obtained from TIMSS 1<sup>st</sup> session and 2<sup>nd</sup> session were given in Table 3.

Table 3.

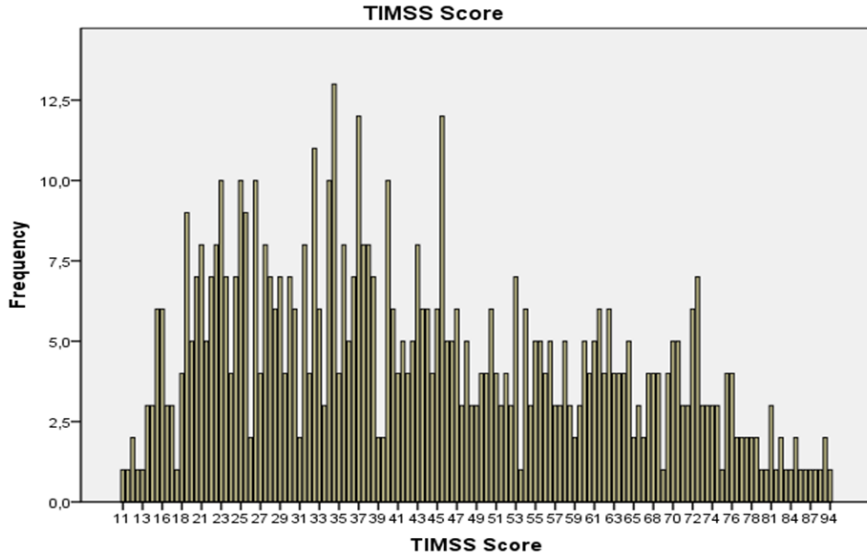
*TIMSS Score Descriptive Analysis Results*

TIMSS	N	Minimum	Maximum	Mean	Median	Mode	Std. Deviation
Score	652	11	94	43.38	40.00	34	18.706

According to Table 3, students' general TIMSS scores vary between 11 and 94 score. Students' average TIMSS achievement score is 43.38. That is to say, a majority of

students scored below 50. This result is fairly consistent with the scores obtained in TIMSS 2011 of Turkey (Büyüköztürk et. al., 2014).

In figure 4, TIMSS mathematics general scores and the frequency values of the scores were given. According to the findings, a significant part of the students'



*Figure 4.* TIMSS score of the students

performed under average. On the other hand, it was clear that only a few students were able to get the achievement score above the average. As it is known, the students who will take TIMSS exam were randomly selected from all cities in Turkey. However, the scope of the study sample covers 8th grade students in one city of Turkey and the results of the sample study were very close to TIMSS general achievement scores. In other words, Turkey shows poor performance in solving mathematics questions in TIMSS. This situation emphasized that Turkey's Education and Training system urgently needed educational reforms for enhancing achievement in mathematics.

### 3.3. Distribution of TIMSS Questions due to Cognitive Learning

#### Domains with Response Frequencies and Percentages

The distribution, response frequency and percentages of the knowing, applying and reasoning components in the first session of TIMSS exams were given as the following table.

Table 4.  
*Response Frequency of the Questions in the First Session of TIMSS due to Learning Domains*

Learning Domains	Question No	True		False		Empty	
		F	%	f	%	f	%
Knowing	1	224	34.4	400	61.3	28	4.3
	5	197	30.2	436	66.9	19	2.9
	7	356	54.6	288	44.2	8	1.2
	9	164	25.2	336	51.5	152	23.3
	10	345	52.9	296	45.4	11	1.7
	13	202	31.0	429	65.8	21	3.2
	18	412	63.2	226	34.7	14	2.1
	21	449	68.9	199	30.5	4	0.6
	24	255	39.1	389	59.7	8	1.2
	<b>Average</b>	289	44.4	333	51.1	29	4.5
Applying	3	200	30.7	447	68.6	5	.8
	4	301	46.2	338	51.8	13	2.0
	6	312	47.9	333	51.1	7	1.1
	8	200	30.7	378	58.0	74	11.3
	12	106	16.3	519	79.6	27	4.1
	15	275	42.2	369	56.6	8	1.2
	20	268	41.1	377	57.8	7	1.1
	22	216	33.1	330	50.6	106	16.3
	23	312	47.9	337	51.7	3	.5
	<b>Average</b>	239	36.7	386	59.1	27	4.1
Reasoning	2	244	37.4	404	62.0	4	.6
	11	216	33.1	285	43.7	151	23.2
	14	452	69.3	194	29.8	6	.9
	16	156	23.9	356	54.6	140	21.5
	17	118	18.1	448	68.7	86	13.2
	19	196	30.1	387	59.4	69	10.6
	<b>Average</b>	230	35.3	346	53	76	11.7

According to Table 4, 652 students answered knowing component questions mostly than applying component questions. The reasoning component was the most unsuccessfully one. Even though reasoning questions had very low achievement, 14<sup>th</sup> reasoning question was observed to have fairly successfully. When the current question is reviewed, it was seen that the case is related with probability subject (Appendix-2). The minimum correctly answered question is 12<sup>th</sup> question from the practice required questions. When the current question is reviewed, it can be seen that the subject of the question is related with the area calculation of a rectangle. In this case, it can be interpreted that the true or false answering ratio of the students can be related with their subject areas. The distribution of the response frequency and percentages of the knowing, applying and reasoning components in the second session of TIMSS exams were given in the Table 5.

Table 5.  
*Frequency and Percentages of the Questions in the Second Session of TIMSS with Learning Domains*

Learning Domains	Question No	True		False		Empty	
		f	%	f	%	f	%
Knowing	8	374	57.4	273	41.9	5	.8
	10	480	73.6	169	25.9	3	.5
	12	271	41.6	377	57.8	4	.6
	14	225	34.5	424	65.0	3	.5
	18	353	54.1	285	43.7	14	2.1
	19	397	60.9	246	37.7	9	1.4
	20	230	35.3	420	64.4	2	.3
	<b>Average</b>	333	51.1	313	48.0	6	.9
Applying	2	429	65.8	215	33.0	8	1.2
	3	199	30.5	446	68.4	7	1.1
	5	360	55.2	291	44.6	1	.2
	6	386	59.2	265	40.6	1	.2
	11	369	56.6	277	42.5	6	.9
	13	330	50.6	316	48.5	6	.9
	15	165	25.3	469	71.9	18	2.8
	<b>Average</b>	321	49.2	324	49.7	7	1.1
Reasoning	1	312	47.9	301	46.2	39	6.0
	4	203	31.1	426	65.3	23	3.5
	7	118	18.1	522	80.1	12	1.8
	9	454	69.6	195	29.9	3	.5
	17	236	36.2	396	60.7	20	3.1
	<b>Average</b>	265	40.6	368	56.4	19	2.9

According to Table 5, the highest mean score was obtained in “knowing” component. It was followed by “applying” component and least achievement was observed for “reasoning” component. Reasoning questions had lowest achievement rate however, 9th reasoning question had the highest achievement rate. It is seen that the current question is related with probability subject when it is reviewed. Also, in the first session, the maximum correctly answered question was about probability subject calls to mind that students show tendency to achievement on solving probability problems. In the second session, the minimum correctly answered question is 7th question from the practice required questions. When the current question is reviewed, it can be seen that the subject of the question is related with fractional numbers. Both the minimum correctly answered and maximum correctly answered questions are in the scope of reasoning required questions class that makes us perceive the correct answering ratio is related with subject area rather than cognitive learning domain.

### 3.4. The Relationships between 8th Grade Students' Dominant Learning Styles and TIMSS Mathematics Achievement

To determine the effect of dominant learning styles on TIMSS achievement score, performed descriptive analysis results were given in the following table.

Table 6.

#### *Descriptive Analysis Results of TIMSS Achievement according to Learning Styles*

Learning Style	N	Mean	Std. Deviation
Auditory learning style	152	43.66	17.958
Kinaesthetic learning style	148	41.64	18.427
Tactile learning style	111	42.56	17.948
Visual learning style	88	44.65	19.580
Individual learning style	79	46.85	19.535
Group learning style	74	42.33	19.903
Total	652	43.38	18.706

As it was observed in Table 6, TIMSS achievement average and standard deviation of the students has auditory learning style were 43.66 and 17.958. TIMSS achievement average and standard deviation of the students have kinaesthetic learning style were 41.64 and 18.427. TIMSS achievement average and standard deviation of the students have tactile learning style were 42.56 and 17.948. TIMSS achievement average and standard deviation of the students have visual learning style were 44.65 and 19.580. TIMSS achievement average and standard deviation of the students have individual learning style were 46.85 and 19.535. TIMSS achievement average and standard deviation of the students have group learning style were 42.33 and 19.903. The results indicated that students who have individual learning style have better results and higher scores in TIMSS.

When the results on the table was checked, the biggest gap among the scores that students have different learning styles was only 5. One-way ANOVA is applied to determine that whether this gap was statistically significant or not. ANOVA results were given at Table 7.

Table 7.

#### *ANOVA Results of TIMSS Achievement according to Learning Styles*

Source of Variance	Sum of Squares	df	Mean Square	F	Significance
Between Groups	1705.956	5	341.191		
Within Groups	226077.185	646	349.965	.975	.432

ANOVA results indicated that there was no significant relationship between TIMSS Achievement and learning styles [ $F(5,646) = .975, p > .05$ ]. In other words, TIMSS achievement score did not significantly change based on learning style. According to ANOVA results, it was determined that there was not any relationship between learning styles and Mathematics achievement and these results were also tested by Correlation Analysis. Correlation results were given at the Table 8.

Table 8.

*Correlation Results of TIMSS Score and Learning Styles*

		TIMSS Score	Learning Style
TIMSS Score	Pearson Correlation	1	.016
	Sig. (2-tailed)		.677
	N	652	652
Learning Style	Pearson Correlation	.016	1
	Sig. (2-tailed)	.677	
	N	652	652

As Table 8 demonstrated, there was not a significant relationship between TIMSS score and learning style [ $r=0.016, p>.05$ ]. These findings confirmed results obtained from ANOVA analysis.

#### 4. Discussion and Conclusions

In this session, findings of the research have discussed according to research problems. In this research, firstly it is aimed to identify students' dominant learning styles (due to Reid's Perceptual Learning Style Questionnaire). When the findings are examined, it is seen that students' the most dominant learning style is auditory learning style. Kinaesthetic learning style follows it. The weakest learning style is group learning style. However, when general evaluation is done it is seen that there are lots of students who have different learning styles (See Table 2). When the literature is examined, it draws attention that students' dominant leaning styles change according to learning style inventories and students have different learning styles (Matthews, 1996; Ekici, 2002; Arslan & Babadoğan, 2005; Yenilmez & Çakır, 2005; Yılmaz-Soylu & Akkoyunlu, 2009; Metin et. al., 2011; Ergin & Sarı, 2015). As is known, teaching lesson according to students learning styles contribute to their achievement (Given, 1996; Koçak, 2008). Even though, in this study it is presented that students dominantly have auditory leaning styles, when TIMSS achievement is examined according to learning styles, it is seen that the most successfully students have individual learning style (See Table 6). Although achievement of the students who have auditory learning style takes place in top spots, it is seen that TIMSS maths achievement of students who have kinaesthetic learning style is the lowest one (See Table 6). Students who have kinaesthetic learning style are more vibrant / energetic and they can easily learn thanks to physical activities. Unfortunately, most teachers use traditional method although constructivist approach has been adopted in Turkey. For that reason, students who have kinaesthetic learning style cannot take advantages

of traditional method. In that case, primarily identifying students' learning styles and teaching lessons according to these learning styles are prior conditions.

When the applied TIMSS exam results of Turkey were evaluated, a majority of the 8th grade students were observed to have low TIMSS mathematic results and the average TIMSS scores of Turkey were below the average TIMSS scores. This finding is consistent with the real TIMSS exam results (Mullis et al., 2008; Yücel et al., 2013). TIMSS exam was applied within the scope of this study, and it is seen that students' TIMSS mathematics achievement was really low and it was below the average (See Table 3). Although this study has just comprised Bayburt city, this finding shows parallelism with real TIMSS results. Unfortunately, it was seen that Turkey had a low performance trend on TIMSS Exams.

Response frequency and percentages of the 8th grade students for the questions in TIMSS exam and the questions distribution due to cognitive areas were examined in the scope of the research. According to the findings, it was noticed that most of "knowing" questions were answered correctly by students, "reasoning" required questions were generally answered wrongly or not answered. When the questions on first and second session in TIMSS exam are evaluated separately, it was seen that the most correctly answered questions were mostly related with knowledge; the most non-answered questions are related to reasoning. These findings bring to mind that students' Mathematics learning process was based on memorization because the most corrected answered questions were related with knowledge. In contrast, reasoning questions were answered incorrectly or unanswered by students. Besides Küçük, Şengül & Katranç (2014) emphasized the reason why Turkey fails on TIMSS exam was associated with rote memorisation based education system and not providing education based on practices. Moreover, the most correctly answered questions are reasoning required questions indicated that subject area affected the accuracy of the response rather than cognitive learning domain. On the other hand, the most correctly answered questions' subject is probability and relate to reasoning that support this finding. It can be said that students are more successfully to answer the questions from some specified subject areas.

The result of the descriptive analysis indicated that students who had individual learning styles were more successfully than other student groups. It was found that the relationship was not significant according to one way variance analysis and correlational analysis results. That is to say, there was not any relationship between students' dominant learning styles and TIMSS Mathematics achievement. However, Kablan & Kaya (2013) performed a similar research for Science Course, and they spotted a significant relationship between learning styles and TIMSS Science achievement. Ma & Ma (2014) proved that relationship between learning styles and mathematics achievement might differ regarding countries. The present study was local and was performed only in Bayburt in Turkey. For this reason, the obtained results are valid only for this kind of sample. Consequently, determining the



relationship between learning styles and TIMSS achievement by doing the similar research on the different types of samples can be useful for obtaining more generalizable and global results.

### 5. Suggestions

As a result, it was seen that students' TIMSS Mathematics achievement were low and they were more successful on the knowledge questions. Besides, that it was determined that correct response ratios of some subject areas were very high. For this reason, increasing this kind of surveillance studies can be useful to determine the factors which caused failure.

For further research, the type of questions that will be asked on which type of subjects in TIMSS exams should be checked and reviewed. These question types and subject areas should be integrated to mathematics course books followed in Turkey. Also, Güner, Sezer & Akkuş-İspir (2013) determined in their research that chapter numbers should be decreased; however question variety and the number of question required reasoning competent-practice should be increased. On the other hand, the successfully countries such as Hong Kong, Korean, and Japan in TIMSS should be searched and how they teach the lesson should be examined. In consideration of the obtained information, required reforms should be implemented in Turkish education system.

In conclusion, despite the fact that there is no significant relationship between learning styles and TIMSS mathematics achievement, it was seen that the achievement level of the students who have the some learning style is higher than the others. As commonly believed, if the educational activities and curriculum are more consistent with students' learning style, this overlap enables easier learning and long term retention. Thus, students' TIMSS Mathematics achievement levels should be tried to increase by means of establishing suitable learning environments which provides their comprehensions by using suitable learning strategy and method for each student instead of making the students memorised the math subjects.

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### Genişletilmiş Özet

Öğrenme sürecinde her bir öğrencinin sahip olduğu özel bir öğrenme stili mevcuttur ve bireyler yeni ve karmaşık bilgiyi öğrenmede, anlamada ve hatırlamada sahip oldukları öğrenme stillerini kullanırlar. Alanyazın incelendiğinde öğrenme stillerinin tespit edilmesi için çok sayıda model geliştirildiği görülmüştür. Bu modellerin başlıcaları ve çalışmalarda en sık kullanılanları Gregorc Öğrenme Stili, Grasha

Öğrenme Stili, Dunn ve Dunn Öğrenme Stili, McCarthy Öğrenme Stili, Kolb'ün Öğrenme Stili ve Reid'in Öğrenme Stili'dir. Bu çalışmada soru sayısının fazla olmaması, okunması ve uygulanmasının kolay olması ve 8. sınıf öğrencileri için kolay anlaşılabilir sorular içermesi nedeniyle Reid (1987)'in öğrenme stili envanteri tercih edilmiştir.

Reid'in öğrenme stili envanteri işitsel, görsel, dokunsal, kinestetik, bireysel ve grupla olmak üzere altı öğrenme stilinden oluşmaktadır. İşitsel öğrenme stiline sahip öğrenciler, işitsel yetileri ile öğrendikleri bilgileri diğer duyu organlarıyla öğrendiği bilgilere göre daha kolay hatırlarlar ve geri getirebilirler. Görsel öğrenenler, görme duyusunu kullanarak öğrenmeyi diğer duyu organlarından daha fazla kullanırlar. Bu öğrenme stilinde olan öğrenciler; tablo, şekil, çizelge, grafik, tasarım ve resimlerden hoşlanırlar. Gözlem yaparlar, takip ederler, yazılarını ifadeye şekillere döker, jest ve mimikleri çok fazla kullanırlar, baş salları ve gördüğünü unutmazlar. Dokunsal öğrenenler elle yaptıkları, yazdıkları, çizdikleri, dokundukları şeyleri hatırlarlar. El-göz koordinasyonları iyi gelişmiştir. Dokunma duyuları ile hissettiklerini hatırlarlar geri getirmeye üstündürler. Maket, biblo, heykel ve somut materyaller bu öğrenme stiline sahip öğrencilerin hatırlama ve hatırdan geri getirmeye diğer öğrenme sistemlerine göre daha üstlerdedir. Kinestetik öğrenenlerin ilgisini hareket ve eylem çeker, ders dinleme, sürekli sabit oturma gibi öğrenmenin daha pasif geçtiği zamanlardan sıkılırlar. İnce kas gelişimleri kuvvetlidir. Bireysel öğrenme stiline sahip öğrencilerin tek başına çalışıp öğrenmeyi, tek başına sorumluluk almayı seven özellikleri vardır. Yeteneklerinin farkındadırlar. Tek başına çalışmaya yönlendirildiğinde başarılı olacağını düşünürler. Grupla öğrenme stiline sahip öğrencilerin tek başlarına konsantre olma ve odaklanamama problemleri vardır. Grup arkadaşları içerisinde iş bölümü yapar ve organizasyonun tamamlanması ile birlikte en yüksek performansını gösterirler. Bu öğrenme stilindeki öğrencilerde küme çalışması yöntemi başarılı sonuç alınmasına sebep olur.

TIMSS (Uluslararası Matematik ve Fen Eğilimleri Araştırması), 4 yıllık periyotlarla 4. ve 8. sınıf öğrencilerine uygulanan ve matematik ile fen bilimleri alanlarındaki eğitim-öğretimi geliştirmek amacıyla ülkelerin eğitim sistemleri hakkında karşılaştırmalı veri toplamak amacıyla yapılan bir sınavdır. TIMSS sınavına katılan ülkeler, kendilerinin dünya ülkeleri arasında matematik ve fen alanlarında hangi düzeyde oldukları hakkında fikir edinebilirler. TIMSS sınavının her dört yılda bir yapılıyor olması bir önceki sınavın yapıldığı yıla göre ülkenin eğitimdeki politikalarının veya eğitim sisteminin ilerleyip ilerlemediği, ülkenin eğitim durumunu nasıl iyileştirebileceği ve başarılı olan ülkelerin başarılı olmasındaki temel etmenlerin neler olduğunun cevaplarının bulunmasına yardımcı olur. Ancak genel olarak Türkiye, yapılan TIMSS sınavlarında matematik alanında ortalamanın altında bir başarı sergilemektedir. Bu da ülkemizdeki öğrencilerin neden bu sınavda yeterli başarıyı gösteremedikleri sorusunu akla getirmektedir.

Bu çalışmanın amacı sekizinci sınıf öğrencilerinin öğrenme stilleri ile TIMSS matematik başarıları aralarında bir ilişki olup olmadığını, ilişki varsa hangi öğrenme stiline sahip öğrencilerin daha yüksek TIMSS başarıları gösterme eğiliminde olduklarını tespit etmektir. Çalışmada nicel araştırma yöntemleri içerisinde yer alan ilişkisel araştırma yöntemi kullanılmıştır. Araştırmanın örneklemi, Bayburt merkezde 11 farklı orta okulda öğrenim gören 347'si erkek, 305'i kız olmak üzere 652 sekizinci sınıf öğrencisinden oluşmaktadır. Araştırmada iki veri toplama aracı kullanılmıştır. İlk veri toplama aracı Reid (1987) tarafından geliştirilen ve Bengiç (2008) tarafından Türkçe'ye çevrilen Algısal Öğrenme Stili Envanteridir. İkinci veri toplama aracı, açıklanan TIMSS 2011 matematik soruları arasından seçilen ve uzman görüşleri doğrultusunda oluşturulan 45 soruluk başarı testidir. Verilere SPSS programında frekans, yüzde, ortalama, standart sapma, ANOVA ve korelasyon analizleri uygulanmıştır.

Çalışma sonucunda öğrencilerin baskın olarak işitsel, ikinci sırada ise kinestetik öğrenme stiline sahip oldukları görülmüştür. Öğrencilerin genel TIMSS başarı puanları 11 ile 94 arasındadır ve ortalama TIMSS başarı puanı 43.38'dir. Ayrıca öğrencilerin sahip oldukları öğrenme stilleri okul, cinsiyet, matematik karne notu, anne ve baba eğitim düzeyine göre farklılık göstermemektedir. Yani çalışma sonucunda öğrenme stilleri ile TIMSS matematik başarıları arasında anlamlı bir ilişki olmadığı tespit edilmiştir.

### Appendix-1: Perceptual Learning Style Preference Questionnaire

Questionnaire Statements	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1. When the teacher tells me the instructions, I understand better.					
2. I prefer to learn by doing something in class.					
3. I get more work done when I work with others.					
4. I learn more when I study with a group.					
5. In class, I learn best when I work with others.					
6. I learn better by reading what the teacher writes on the chalkboard.					
7. When someone tells me how to do something in class, I learn it better.					
8. When I do things in class, I learn better.					
9. I remember things I have learned in class better than things I have read.					
10. When I read instructions, I remember them better.					
11. I learn more when I can make a model of something.					
12. I understand better when I read instructions.					
13. When I study alone, I remember things better.					
14. I learn more when I make something for a class project.					
15. I enjoy learning in class by doing experiments.					
16. I learn better when I make drawings as I study.					
17. I learn better in class when the teacher gives a lecture.					
18. When I work alone, I learn better.					

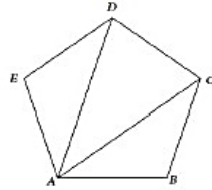
19. I understand things better in class when I participate in role-playing.					
20. I learn better in class when I listen to someone.					
21. I enjoy working on an assignment with two or three classmates.					
22. When I build something, I remember what I learned better.					
23. I prefer to study with others.					
24. I learn better by reading than listening to someone.					
25. I enjoy making something for a class project.					
26. I learn best in class when I participate in related activities.					
27. In class, I work better when I work alone.					
28. I prefer working on projects by myself.					
29. I learn more by reading textbooks than by listening to a lecture.					
30. I prefer to work by myself.					

### Appendix-2: Examples of TIMSS Questions

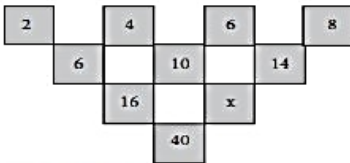
**Question-1:** What is the sum of all the interior angles of pentagon ABCDE?

Show your work.

Answer:



**Question-2:**



What is the value of  $x$  in this pattern?

Answer:

**Question-3:** A machine has 100 candies and dispenses a candy when a lever is turned. The machine has the same number of blue, pink, yellow, and green candies all mixed together. Megan turned the lever and obtained a pink candy. Peter turned the lever next. How likely is it that Peter will get a pink candy?

- It is certain that his candy will be pink.
- It is more likely than it was for Megan.
- It is exactly as likely as it was for Megan.
- It is less likely than it was for Megan.