ENGAGING 6TH GRADE STUDENTS WITH MATHEMATICS BY USING MULTIPLE INTELLIGENCE THEORY

A MASTER'S THESIS

BY

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I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

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ABSTRACT

ENGAGING 6TH GRADE STUDENTS WITH MATHEMATICS BY USING MULTIPLE INTELLIGENCE THEORY

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Mathematics is a source of fear for many students and many struggle while learning mathematics. Most believe that they do not have the ability to learn mathematics and this perception decreases their motivation. The relationship between teaching and learning mathematics has been improved by integrating various approaches into the mathematics lessons. By 2000s, multiple intelligence theory was taken into consideration as one such approach in Turkey.

This study aimed to explore whether there was a correlation between 6th grade students' multiple intelligence types and their preferences of components of math lessons addressing multiple intelligence theory. The study was completed with fourteen 6th grade

students with ages ranging from 11- 13 years at Ankara Bilkent Laboratory and International School, Turkey.

In the first session of the study, students' multiple intelligence types were identified by administering a multiple intelligence survey. Then several mathematics lesson activities based on multiple intelligence theory were implemented during 2 math lessons in block schedule to discover students' preferences of learning mathematics. In the next session students were expected to describe how their learning was affected by classroom activities based on the multiple intelligence theory. Students reflected on which activities they liked and which activities were most effective by rating the activities in the given reflection forms. Students' reflections and their personal intelligence types were correlated. It was found that bodily-kinesthetic intelligence was rated to be the most dominant intelligence among the participating 6th grade students. However, lesson activities addressing linguistic and mathematical-logical intelligences correlated highest with students' mathematical learning.

Key words: Mathematics education, multiple intelligence theory, alternative methods for teaching mathematics

ÖZET

ÇOKLU ZEKÂ KURAMI ÜZERİNE OLUŞTURULMUŞ MATEMATİK DERSLERİNİN 6.SINIF ÖĞRENCİLERİNİN ÖĞRENME TERCİHLERİ İLE İLİŞKİSİ

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Matematik dersi birçok öğrenci için öğrenilmesi zor bir ders olarak kabul edilmektedir. Öğrencilerin genel olarak matematiğe karşı duydukları korku bu dersteki başarılarını etkileyen bir etkendir. Eğitimciler matematik öğrenme ve öğretme arasındaki ilişkiyi geliştirmek için çeşitli pedagojik yaklaşımlar geliştirmişlerdir. Çoklu zekâ kuramı da eğitim alanında etkili olan kuramlardan birisi olup 2000'li yıllarda Türkiye'de ön plana çıkmıştır.

Bu çalışmada 6. sınıf öğrencilerinin matematik öğrenim sürecinde, sahip oldukları çoklu zekâ türleri ve matematik öğrenme tercihleri arasındaki ilişki araştırılmıştır. Çalışmaya

Ankara Bilkent Laboratuar İlköğretim ve Bilkent Uluslararası Okullarında aynı sınıfta öğrenim gören 6.sınıf düzeyinde 14 öğrencinin katılmıştır.

Çalışmanın ilk aşamasında öğrencilere çoklu zekâ anketi ve ardından araştırma boyunca temel alınacak çoklu zekâ türlerine yönelik etkinlikler içeren matematik dersleri uygulanmıştır. Uygulanan çoklu zekâ ders aktivitelerinden hangilerinin öğrencilerin öğrenmeleri üzerinde daha etkin olduğunu ortaya çıkarmak üzere düşünce yansıtma anketi uygulanmıştır. İlk aşama ve son aşamada elde edilen nicel verilerin korelasyonları hesaplanarak aralarındaki ilişki değerlendirilmiştir. Çalışmanın bulgularında 6.sınıf öğrencileri arasında en önde gelen zekâ türünün bedensel-kinestetik zekâ olduğu görülmüştür. Öğrencilerin algıladıkları şekliyle, uygulanan matematik derslerinde sözel-dilsel zekâ ve matematiksel-mantıksal zekâya hitap eden ders aktivitelerinin en verimli matematik öğrenme etkinliği olduğu bulunmuştur.

Anahtar Kelimeler: Matematik eğitimi, çoklu zekâ kuramı, matematik öğrenimi için alternatif yöntemler

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CHAPTER 1: INTRODUCTION

Introduction

Mathematics is a source of anxiety for many students. Most of them dislike it and believe that there is little connection between mathematics and real life. They often try to memorize the formulas and have difficulty understanding the concepts underlying formulas. There are many students in a math classroom with distinct learning styles and different learning preferences. Students' fear and anxiety about learning mathematics can be reduced by applying alternative teaching methods by their mathematics teacher (Sherman & Wither, 2003). Differentiated instruction reflects the importance of alternative teaching methods for learners. This approach emphasizes meeting different needs of students in a classroom (McNamara et al., 1999). One of the most common ways of differentiated instruction is implementing the MI (multiple intelligence) theory in the classroom, which has been gaining increasing prominence among educators (Gangi, 2011).

MI theory aims to help students' engagement during the lesson and helps enrich students' learning environment (Douglas et al., 2008). According to the MI theory, students need to discover their learning preferences to understand mathematics by using multiple teaching tools (Şengül & Öz, 2008). Implication of MI theory is one way to make learning mathematics more enjoyable and understandable for students.

Eight distinct intelligence types are described by Howard Gardner, the initiator of MI theory: naturalistic, musical, mathematical-logical, interpersonal, bodily-kinesthetic,

linguistic, intrapersonal and visual intelligences (Gardner, 1993). This study focuses on the 6 types of intelligences: mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences to discover the relationship between 6th grade students' multiple intelligence types and their preference of components of math lessons that tap into different types of intelligence at a private school in Ankara. The correlation between students' learning preferences and their intelligence types based on the MI theory is explored. This study would be helpful for educators especially mathematics teachers on their way to meet the needs of students with different intelligence types in a classroom while teaching mathematics.

Background

Learning is part of an individual's lifelong developmental process and it is the permanent change in an individual's behaviour based on interactional experiences with the environment around them (Bransford et al., 2006). Learning is such an adaptation process that it is the way for individuals to meet their needs to survive and interact with their own environment based on their experiences (Londe, 2006). Learning is explained by a multitude of learning theories in psychology such as the cognitive learning theory. "It posits that with effective cognitive processes, learning is easier and new information can be stored in the memory for a long time" (Sincero, 2011, p.3). Learning is influenced by extrinsic factors such as culture and experiences. Therefore the awareness of a student's own reasons and perceptions on learning is essential for a teacher to help students attain learning (Sincero, 2011).

Differentiated instruction requires the awareness of differences among students' perceptions of learning. It suggests teachers apply alternative teaching methods to

reach every student in a classroom by taking care of different needs of students (Fischman, 2011). Involvement of the maximum number of students during a lesson is the key component of differentiated instruction. Differentiated instruction presumes that this is possible by discovering the learning differences among students (McNamara, 1999).

MI theory is one way of discovering differences among students. It explains the functions of different types of intelligence for individuals. MI theory proposes that each individual has different combinations of different types of intelligences. The theory suggests educators follow a philosophy of teaching based on a variety of intelligence types and learning preferences of students (Gardner, 1993).

The Turkish national curriculum is based on a traditional teaching strategy which supports a teacher-centered approach that ignores the different learning needs of students, but it started changing in 2003. The system is on its way to becoming a student-centered approach, especially the elementary education system. It has made many innovations in its learning and teaching approaches such as new textbooks based on multiple activities, teaching strategies, and active learning techniques. All these innovations aim to make students an active part of the lesson by reflecting on their newly acquired knowledge during lessons (Koç et al., 2007). Reform in the education system enriches teaching and learning approaches. The MI theory is considered to provide one of the most attractive educational approaches in recent times.

The examination system in Turkey is confusing and stressful for students. Students need to take these examinations after 8^{th} and 12^{th} grade to enter a high-school and university. Multiple-choice questions are asked in these exams which assess

students' knowledge directly. They are often far from encouraging students to show their creativity and critical thinking. The system encourages students to learn by rote most of the times (Kaya, 2006).

Private schools are more likely to apply new teaching and learning theories for students to help them become more confident and ready for their future. Learning takes on greater meaning with students' active participation during the course especially mathematics needs students' activeness (Kaya, 2006). Mathematics expects students to think differently and apply their own problem solving abilities in a creative way. MI theory is attractive to many private schools in Turkey to deliver better education. Furthermore some educational seminars take place within private schools to discuss about new educational approaches and how to enrich the relationship between teaching and learning (TPSC, 2011).

Problem

Self-awareness is an essential component of the learning process. Students need to explore their ability to learn. Individuals have different types of intelligence which reflect their different learning preferences as stated in Howard Gardner's multiple intelligence theory (Gardner, 1993). Since every pupil has own learning preference and different ability to learn mathematics, teaching mathematics requires being aware of students' needs and learning preferences (Boley, 1999).

The traditional teacher-centered approach to teaching does not encourage students' involvement during the lesson but directs students to apply memorization of mathematical concepts (Gresham, 2007). Young individuals are more open to learn fundamental concepts in any subject area. They tend to discover their intelligence

profiles and how to learn best. MI theory can assist teachers in noticing students' intelligence types and applying different activities that meet the needs of students in the classroom. Since there might be students with a variety of intelligences in a math classroom, it is important for teachers to be aware of the different needs of students and plan lessons accordingly (Fischman, 2011).

It should be investigated if classroom activities based on MI theory in a math classroom help students' learning effectively. The correlation between students' MI types and learning preferences is needed for mathematics teachers to have an efficient teaching and learning relationship. Multiple intelligence theory can provide insight into students' learning however research is necessary to discover if lesson activities tapping into MI theory are helpful for the students with different MI profiles in the math classroom.

Purpose

The main purpose of this study was to explore whether there was a correlation between 6th grade students' multiple intelligence types and their preferences of components of math lessons. A survey that helped identify students' MI types was the instrument used to identify students' MI profiles. Several mathematics activities based on MI theory were implemented during two math lessons in a block schedule to discover students' needs while learning mathematics. After applying MI activities in the classroom, students were expected to describe how their learning was affected by the classroom activities based on MI theory. Students reflected upon which activities were most effective for them by rating the activities in the given reflection forms. Students' reflection forms were correlated with their multiple intelligence

types to seek for relationships between students' dominant MI types and their learning preferences.

This study will provide educators with ideas about 6th grade students' preferences for learning mathematics based on dominant intelligence types. Mathematics teachers may pick up ideas from this study about how to teach mathematics based on the correlations between MI types and learning preferences of middle school students.

Research questions

The main research question of the study was: Is there a relationship between 6th grade students' multiple intelligence types as elicited by a multiple intelligence survey and their learning preferences for components of a math lesson that address different types of intelligence as perceived by students?

Sub-questions were;

- What are the multiple intelligence profiles of 6th grade students?
- Is there a significant correlation between students' primary types of intelligence and their liking of the lesson activities as perceived by students?
- Is there a significant correlation between students' primary types of intelligence and the effectiveness of learning from lesson activities as perceived by students?

Significance

MI theory has been considered as a way of improving the relationship between teaching and learning mathematics in Turkey since 2003. Seminars and trainings have been arranged periodically to inform teachers about MI theory and start

applying it in their classrooms (Kaya, 2006). Individuals who are interested in teaching and learning mathematics based on the needs of students may benefit from this approach.

The effects and consistency of MI theory are discussed in terms of different perspectives such as math teacher, pre-service teacher and students. Therefore the results of this study may provide ideas to elementary math teachers about how to be aware of students' intelligence types and ability to learn mathematics. MI lesson activities used during this study may be an inspiration for math teachers to apply and develop similar approaches. Administrators and curriculum developers may find this study useful in the development of education based on MI theory and its significance in math education.

Definition of key terms

It is stated that "intelligence is the bio-psychological potential to process information that can be activated in a cultural setting to solve problems or create products" (Gardner, 1999, p.33). Similarly intelligence was explained as "the power of adaptation to environment in new and surprising conditions, the power of abstraction and problem solving" (Selçuk, 1999, p.63). Intelligence can be expressed as a treasure for individuals that it opens different windows by the help of different perspectives (Munger et al., 2010). If the theories about intelligence are considered in an overall perspective, it seems that general intelligence contains different types of intelligence concomitantly; it can be observed and assessed by several intelligence tests like multiple intelligence surveys (Spearman, 1904).

The initiator of multiple intelligence theory, Howard Gardner, postulated that there are multiple skills and abilities related to individuals and their intelligences (Gardner, 1999). There are several definitions of multiple intelligence theory, however all definitions have a similar perspective in their explanation. Firstly, Howard Gardner's is the basic definition of MI theory which states individuals have different sorts of intelligence and skills that help people respond to the environment around them. Multiple intelligence theory explains intelligence as a set of variety types of skills. An individual can have different aspects of the types of intelligences during their life however some of them can be observed as dominant (Gardner, 1993).

The types of intelligences are categorized into eight areas: naturalistic, musical, mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences (Gardner, 1993). According to multiple intelligence theory, individuals interpret or express themselves by using the type of intelligence skills related to their own culture (Temur, 2007).

On the contrary, there are some educators who believe that exploring students' types of intelligence is a necessary step for their learning. However, everyone does not agree on the ways to integrate MI theory into classroom practices; for example Collins (1998) claims that MI theory can be a time loss problem for teachers and students on losing time during a lesson if it is not used carefully. Collins also states that the MI theory can lead to "an emphasis on less important skills and to a false sense that learning has taken place when it has not" (Collins, 1998, p. 95).

Learning mathematics in an effective way requires alternative teaching tools based on naturalistic, musical, mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences (Munger et al., 2010). Naturalistic

intelligence thinks through nature and learns through gardening and investigating the nature. Naturalistic intelligence needs access to nature to learn best since when they connect knowledge with nature learning comes easier to them (Armstrong, 2009).

Some students' musical intelligence is dominant and they think via rhythms for singing, listening and whistling. Teachers may provide lesson activities for these students based on listening or playing some instruments (Armstrong, 2009).

Mathematical-logical intelligence reflects the ability to think and reason while experimenting, questioning and calculating. The key idea for teachers is that mathematical-logical intelligence needs materials to experiment with and manipulatives which make them think critically (Sousa, 2008).

Students with dominant interpersonal intelligence mostly think by interacting with others and they enjoy organizing, relating and sharing ideas with others. It is effective for teachers to plan group working activities, games and social gatherings for interpersonal intelligences in the classroom (Armstrong, 2009).

Students with a dominant bodily-kinesthetic intelligence think through bodily sensations such as dancing, running, jumping, touching and building. Bodily-kinesthetic learners require movement, physical games, tactile experiences and hands-on learning tools during their learning process (Gardner, 2005).

Linguistic intelligence reflects the ability to think in words and a student with linguistic intelligence type mostly likes reading, writing, telling stories and playing word games. Teachers should be aware of students with dominant linguistic intelligence and their need for books, writing tools, paper diaries, dialogues, discussions and stories during their lessons (Armstrong, 2009).

In contrast to interpersonal intelligence, students with an intrapersonal intelligence prefer thinking in relation to their own needs and goals with a preference for planning, reflecting and mediating. Intrapersonal intelligent students need individual studying and self-based projects (Armstrong, 2009).

When images and pictures are the key components of an individual's thinking process with understanding coming from drawing, visualizing and designing, his/her intelligence type is described as visual intelligence. Teachers should be aware that students with a dominant visual intelligence need videos, slides, imagination games and illustrated books (Armstrong, 2009).

CHAPTER 2: REVIEW OF RELATED LITERATURE

This literature review explores the relationship between multiple teaching methods used in a math classroom and students' learning preferences based on multiple intelligence theory. The focus is on the implications of MI theory as it relates to students' learning of mathematics. There are definitions of intelligence from different perspectives and MI theory with its 8 different intelligence types; naturalistic, musical, mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences. Why math teachers need MI theory during learning and teaching process and how to apply it in the math classrooms, especially middle grade students, is discussed behind.

History of multiple intelligence theory

Alfred Binet first coined the term "intelligence quotient" which is based on measuring the cognitive abilities and memory capacity of individuals. Then Lewis M. Terman worked on the Binet test to advance it to measure individuals' abstract thinking skills in 1916 and it was named the Stanford-Binet Scale. Interestingly, in the early 1940s it was proposed that intelligence does not consist of only one characteristics and he published an intelligence test based on measuring the performance and linguistic ability of individuals (Teele, 1992).

Louis Leon Thurstone contributed to the idea of multiple aspects of intelligence with several psychological tests and accepted intelligence as having verbal, numerical and

visual aspects. Additionally he provided evidence that people have difference levels of these aspects of intelligence (Thurstone, 1938).

In the 1960s, the concept was rejected that is a unitary construct. After discovering a variety of characteristics of intelligence in 1982, educators began to work on informing teachers on how to adapt their curriculum and teaching plans by considering differences between students (Glaser, 1982). Howard Gardner recommended the multiple intelligence theory which described intelligence as having multiple abilities (Gardner, 1999). Multiple intelligence theory suggests measuring intelligence based on different aspects differently than IQ tests which focus mostly on the linguistic and logical ability of individuals. "Standard IQ tests measure knowledge gained at a particular moment in time; they can only provide a freeze-frame view of crystallized knowledge" (Helding, 2009, p.196). A standard IQ test is not the single way to assess an individual's ability to learn. It is possible that some students could be a good painter, although they may not be doing equally as well in mathematics (Gardner, 1999). Multiple intelligence theory questions the standard of giving IQ tests and suggests alternative opportunities for students to be responsible for their own learning (Köroğlu & Yeşildere, 2004).

MI theory and education

In the field of education, the awareness of different learning preferences of students in the classroom is the key component for effective teaching and learning to happen. In the past, different grade students were taught in the same classroom, for example 2nd and 5th grade students were taught in the same classroom with the same teacher. Therefore teachers needed to differentiate the curriculum to teach different grades at the same time which was challenging for teachers. In the same way, teachers take

care of differentiated instruction for their students who are in the same grade and in the same classroom (Anderson, 2007). Teachers need to apply differentiated instruction to reach every student with a variety of needs in the classroom.

Differentiated instruction requires teachers to identify students' readiness and interests. Readiness reflects students' background knowledge related to a topic, interest refers to students' motivation and willingness to learn (Tomlinson, 2001). Readiness of students may be discovered by teachers before and during the lesson with several activities. Multiple intelligence theory is one of promising ways of identifying students' learning profiles in terms of students' ability to learn (Gangi, 2011). Teachers should be aware of each student's dominant intelligence type to help them engage in the lesson and motivate them to learn.

Learning mathematics requires motivational tools (Sherman & Wither, 2003). Students often believe that they cannot do math and have little ability to learn. However people are born with considerable capabilities, a well-known one is language skill that everyone accepts as an ordinary ability. Similarly people have a natural number sense although, they may not be aware of it. It is interesting that people accept language as a natural skill but not mathematics. It shows that abstract mathematics, which has a special language with notions and terminologies, makes people believe it is difficult. At this point mathematics education can help individuals discover their ability to learn mathematics that they already have (Sousa, 2008). Since every student has different learning abilities mathematics teachers should be aware of the variety of intelligences in the classroom.

Multiple intelligence theory is one way to describe the variety of learning preferences among individuals. When students are aware of their personal primary

intelligence types, they have the opportunity to express themselves strongly based on their intelligence types. Students start to gain self-confidence in the classroom because they realize their learning strategies that work (Allen, 1997). In terms of math lessons, if teachers prepare a lesson plan that appeals to each intelligence type in the classroom, learning comes closer to students. Each student makes an effort to learn mathematics when they feel the lesson is constructed with care for them (Talu, 1999).

Students' emotions, expectations and the classroom atmosphere all have an effect on learning process (Dwyer, 2001). Classroom atmosphere should be appropriate for different types of activities which help students meet their needs, and for teachers to meet their instructional goals aimed at reaching every pupil (Carson, 1995). Students differ from each other in terms of different educational backgrounds and learning experiences. They perceive the world from different perspectives. Monotype lesson plans should not be expected to fit all the students. Therefore it is important for teachers to know students' learning preferences in order to reach all of them at the same time. At this point MI theory helps math teachers to be aware of students' needs and make math lessons accessible for each student in the classroom (Munger et al., 2010).

Multiple intelligences and learning styles

In recent times every teacher has heard about the terms multiple intelligences and learning styles. However, most of them do not know what these two terms mean. Many teachers do not search for information on multiple intelligence theory and learning styles. They prefer to believe multiple intelligences and learning styles refer to the same meaning (Denig, 2004).

> In order to contribute to effective learning environment, teachers should inevitably possess sufficient knowledge about the learning styles and multiple intelligences of their students and plan the learning process accordingly. These two theories are helpful in the attempts to interpret individual differences and thus, design education models.
>
> (Özgen at al., 2010, p.168)

Multiple intelligences and learning styles are not completely different or completely same. These two theories have both similarities and differences. Both of them are ways to realize the differences among individuals (Guild, 1997). It is possible to hear "In our school we have introduced multiple intelligences which now cater for our students' learning styles" (Prashnig, 2005, p.8). In practice multiple intelligence theory and learning styles have similar results; they contribute learning by working together (Guild, 1997). The distinction between these two popular concepts should be identified by teachers to activate them correctly while teaching.

Gardner (2004) introduced intelligence as the capacity of individuals to respond to the environment around them and everyone may have different abilities. According to Gardner intelligence cannot be measured just by the implementation of mathematics and language tests; intelligence has different aspects. At first he mentioned about the seven different types of intelligences: musical, mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences. Then naturalistic intelligence was defined as the 8th type of intelligence (Saban, 2004). Each individual has a different capacity to use their intelligence. They may have the characteristics of all eight types of intelligences. However, some of the intelligences appear to be dominant in a person and that reflects the individuals' multiple intelligence type. Awareness of a variety of

intelligence types in the classroom is essential for teachers to arrange the curriculum and learning and teaching approaches (Armstrong, 2009).

Learning style explains intelligence as the perception of the environment around the individual psychologically with several environmental factors.

> Learning styles of individuals originate from their perceptional preferences and difficulties, motivational differences, psychological differences and individual differences resulting from practices of processing knowledge. The concept of learning style underlines the ways individual receive, interpret and organize knowledge and the ways and characteristics of their thinking.
>
> (Özgen et al., 2010, p.169)

Multiple intelligence theory and learning styles have some similarities that aim to promote learning. Both of them tend to change the traditional teacher-centered education system to student-centered in which students are expected to take active role in learning. The theories accept differences between individuals and suggest reaching different needs of students in the classroom (Guild, 1997).

On the other hand, there are main differences between the theories of multiple intelligences and learning styles. The main difference between these two concepts is that multiple intelligence theory concentrates on the product of learning, and learning styles concentrate on the process of learning. It means that teachers may apply MI theory to discover what a student learns based on his/her ability and learning styles to discover how a student can learn best (Özgen et al., 2010).

> Multiple intelligences proponents advocate making changes in the methodology used in the classroom, but most emphasize using students' talents in the same way, at the same time, and in the same amount of time. Learning style theory argues for the need to exploit different educational resources in harmony with in what way students with different learning styles learn best.
>
> (Özgen at al., 2010, p.180)

It shows that students may have different learning styles although they have similar multiple intelligence types. Therefore teachers should be aware of both theory to promote students product and process of learning effectively.

Developments after the inception of multiple intelligence theory

There are specific educational strategies based on multiple intelligence theory for different subject areas to increase the awareness of teachers about their students. Individuals have different sorts of intelligence and abilities to learn, or multiple intelligences that could help students respond to the environment around (Gardner, 1993). It is the way to enhance individual's life effectively with the inspiration of self-awareness as learners (Douglos, et al., 2008). Gardner explains intelligence as the set of eight types; naturalistic, musical, mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences. An individual can have different aspect of these types of intelligence during their life however some of them can be observed as dominant. Individuals have different approaches to learning and the teaching process, and use different aspects of their intelligences (Köroğlu & Yeşildere, 2004). According to Allen (1997) students should be encouraged to discover their own learning profiles for effective learning.

It is reasonable to expect that there is a relationship between lesson activities addressing students' dominant intelligence types and their mathematics achievement. It means that students have the opportunity to learn by their own way with the help of multiple intelligence theory (Dobbs, 2001). MI theory is effective for students when learning mathematics by helping them eliminate their lack of self confidence as learners. When students perceive themselves as having the ability to learn mathematics, it is easier to reach them and help them learn mathematics effectively (Donovan & Bransford, 2005).

MI theory maintains that it is important to apply a variety of methods during a lesson to reach students with different intelligence types (Talu, 1999). If the lesson is prepared by using different teaching techniques based on students' learning preferences, it is effective for students' learning (Dunn & Dunn, 1999).

Armstrong (1994) states that the concepts of learning styles and multiple intelligences help us see students thinking differently. However students are not expected to study mathematics according to only one or two (dominant) intelligence types in the classroom. It is aimed to help students develop new personal ways of learning by the inspiration of MI theory (Goodlad, 1984).

MI theory and learning

Most researchers have studied the effects of MI theory on learning mathematics by applying several math activities on a specific mathematics unit (Köroğlu & Yeşildere, 2004; Amanda, 2004; Şengül & Öz, 2008; McGraw, 1997). The key point of the researchers was being aware of students' needs and intelligence types during a lesson. Efficiency refers to comprehensibility of the lesson for learning supported by

applications of MI theory. The teacher is the main character on the discovery of math learning preferences of students and they should be aware of it to make math more understandable (Sousa, 2008). “Students’ understanding of mathematics, their ability to use it to solve problems, and their confidence in and disposition toward mathematics are all shaped by the teaching they encounter in school” (Graham & Fennel, 2001, p. 1). Therefore mathematics teachers should determine targeted learning outcomes to apply aiming at reaching a variety of learning profiles in the classroom to shape students’ mathematics background (Smith, 2004).

MI theory requires many teaching materials and creativity that it is not always easy for teachers to construct. As expressed by Levy (2008) the first requirement of MI theory for teachers is that teachers should be clear on having enough information about their students based on their multiple intelligence types. When math teachers apply MI theory as the way to differentiate the math lessons, it affects their creativity positively as they search for several lesson materials. Teachers’ awareness of different needs in the classroom makes teaching meaningful and teaching materials make math lessons more understandable for most of the students (Köroğlu & Yeşildere, 2004).

When teachers are aware of students’ learning preferences and intelligence types, lesson plans and activities are prepared carefully to reach every pupil in the classroom. Thus the learning atmosphere is more meaningful for learners (Munger, et al., 2010). According to students’ perspectives, math lessons are more enjoyable with MI activities than traditional lessons with a teacher-centered approach (Şengül & Öz, 2008). The aim of math courses based on MI theory is to help students discover their own ability to learn and how to use it.

Furthermore a cooperative learning method is one of the most common alternative teaching approaches for MI theory in a math classroom. The researches (Işık & Tarım, 2005; Janes et al., 2000; Johnson & Johnson 1997) related to the application of the integration of MI theory and cooperative learning indicate that cooperative learning activities are effective on students' mathematics achievement. Since cooperative learning is one of the most common alternative teaching techniques for MI lesson activities, it can support different intelligences in a math classroom. The researches show that students feel themselves comfortable and more successful during cooperative learning activity and they have opportunity to brainstorm with their peers. It is the way to take the attention of students with interpersonal intelligence and also it is essential for other MI types as well. Students' comments support this claim that students like to learn by using several activities and materials during math lessons. Some students found some activities boring and they were not interested in those activities. It shows that because of the differences among intelligences, students may not like some teaching materials so having the sense of balance is crucial for quality and efficiency of learning.

MI theory is needed during not only teaching but also learning mathematics. Researches show that students want to encounter new teaching approaches and learn mathematics outside traditional teaching strategies (Allen, 1997; Denig, 2004; Kulieke, et al., 1990; Temur, 2007; Kaya, 2006; Cooper, 2008). According to the research, MI theory is one way to support students' learning mathematics efficiently. MI theory has a significant impact on students' motivation and encourages them to learn math. The result of the research showed that students wanted to have different activities during a math lesson. These activities could be based on different

intelligence types and while activities were being used, students did not realize how time passed and the lesson ended (Temur, 2007).

Summary

Teaching and learning are in close relationship and students represent the heart of this relationship. Therefore teachers should be aware of the heartbeat in their classroom. In general, the literature reviewed during this chapter showed that students' motivation and interest during a math lesson are the main factors for teachers, on the way to create a desired learning atmosphere. Since mathematics courses are often an unavoidable fear for many students, lots of researchers have studied different theories to make mathematics more understandable and enjoyable. MI theory is one of the alternative theories supporting teaching and learning mathematics with multiple activities. Students need to feel mathematics' nature and beauty to learn it efficiently especially during primary and elementary grade levels, however there are many sorts of students in a classroom in terms of variety of intelligences.

Preparing a lesson plan which is enriched by variety of teaching material and activities based on MI theory is not easy for a teacher. The quality of lesson plan is crucial on students' mathematics that MI theory can make mathematics lesson effective and enjoyable for students. This research will encourage educators to have an idea about using MI theory and its application in math classrooms. The right match between students' reactions as learners during math lessons with several MI activities and their learning preferences is possibly the key point for math educators.

CHAPTER 3: METHODS

Introduction

The main purpose of this study was to explore if there was a correlation between 6th grade students' multiple intelligence types and their preference for components of math lessons that address different types of intelligence. An MI survey was used at the beginning to elicit each student's dominant MI types. Two block mathematics lessons (each 80 minutes long) were then taught with activities that addressed and supported specific types of intelligence. The students were asked to respond to another survey after each lesson in which they rated their liking of these activities and the perceived contribution of these activities to their learning.

Research design

The main research question of the study was: Is there a relationship between 6th grade students' multiple intelligence and their learning preferences of components of a math lesson that address different types of intelligence as perceived by students?

Sub-questions were;

- What are the multiple intelligence profiles of 6th grade students?
- Is there a significant correlation between students' primary types of intelligence and their liking of the lesson activities as perceived by students?
- Is there a significant correlation between students' primary types of intelligence and the effectiveness of learning from lesson activities as perceived by students?

This research reflects a correlation research design. We attempted to determine whether there were relationships between three variables of interest, namely multiple intelligence scores, perceived liking of lesson activities designed for different types of intelligence and perceived effectiveness of learning from these lesson activities (Cohen & Manion, 2007).

Context

Specifically, the present study aimed to explore if there was a relationship between 6th grade students' multiple intelligence types and their preference for components of math lessons that address specific types of multiple intelligence. Figure 1 shows the flow of the procedures of data collection of this study. At the beginning of data collection process, MI survey was conducted as pre-survey in order to elicit students' MI types.

After collecting the pre-survey data, two math lessons using strategies that address MI types were taught. Each lesson included activities based on 6 common intelligence types among participating students. Students had the opportunity to experience activities that highlight mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences.

After classroom activities, students were expected to fill out reflection forms to express their learning preferences by rating the lesson activities they just had during the lesson from two perspectives: the perceived effectiveness of the activity for contributing to their learning, and their liking of the activity.

After collecting the data, the relationship between students' MI types based on pre-survey results and their learning preferences during math course based on post-survey results were examined.

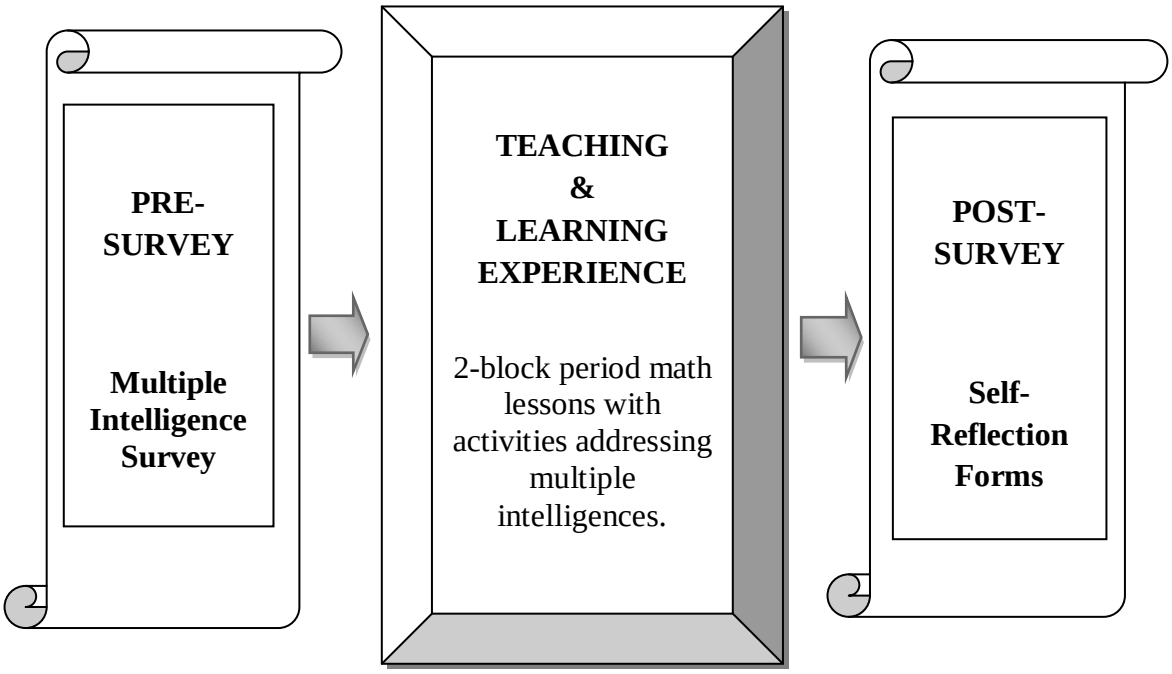


Figure 1. Flow of the procedures of data collection of this study

Participants

This study was completed with the participation of fourteen 6th grade students with ages ranging from 11- 13 years at Bilkent Laboratory and International School in Ankara, Turkey. Students in this school come primarily from higher socio-economic backgrounds and can be considered to have average academic and mathematical ability. This school was selected because teachers use alternative methods of instruction including group work and students were accustomed to the new methods used in the instructional intervention of this study. Before students' participation, parental permission letters were obtained by using school e-mail.

Instrumentation

The MI survey, which gives a snapshot in time of an individual's perceived MI preferences, used in this study was borrowed from McKenzie (1999). The survey was designed to elicit the degree to which an individual agreed with statements intended to be indicators of different types of intelligence.

It consisted of ten statements for each intelligence type so there were eighty statements in total. However at the end of the implementation of survey this study focused on the scores for six intelligence types: mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences. The survey is given in Appendix A. The survey had two parts. In the first part, demographic information such as gender and age was asked in addition to the previous years' end-of-year math grade, and students' three favourite subjects. In the second section, students were asked to indicate if they agree or disagree with 10 statements given for each of the intelligences: naturalistic, musical, mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences. The highest score possible for each intelligence type was 100 for a student based on their response to these statements.

After the MI survey was administered, two math lessons specifically designed to address intelligence types were conducted with this class of 6^{th} grade students. A lesson plan addressing MI theory is given in Appendix C. At the end of the lesson, students filled out self-reflection forms (see Appendix B). These forms were designed to elicit students' liking of the activities and the perceived effectiveness of the activities for students learning for each of the specific activities of the lessons. Self-reflection forms had two parts. The first part consisted of 6 sections which

helped students remember the kinds of things they did during the activities. In the second part, students rated each of the six activities from 1 to 10 twice from two perspectives; i. the degree of perceived effectiveness of the activity for contributing to students' learning, and ii. the degree of perceived attractiveness of the activity for the students in general.

Method of data collection

The pre -intervention quantitative data about each student's MI profile out of 100 were collected after administering the MI survey. Self-reflection forms which were implemented after MI lesson activities produced another set of quantitative (Likert-scale) data, with two different parts.

In summary, for each of the 14 participating students, a set of 8 scores ranging from 0 to 100 representing the degree of primacy of different intelligence types were computed based on the MI survey. However this study only focused on the set of 6 scores ranging from 0 to 100. In the post-survey, again for each student, a set of 6 scores, one for each of the component activities designed to support the following types intelligences, were obtained; mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences. No activities were designed in these lessons that supported naturalistic and musical intelligences since it was difficult to design math lesson activities for these two types of intelligences. Students rated each activity for the perceived attractiveness and its perceived facility to support personal learning of the topic. Accordingly, for each lesson, two sets of 6 scores were elicited from students. Averages of the two ratings across the two lessons were computed for each student, separately for "liking" and "effectiveness", so only one score is used in correlation computations.

Method of data analysis

Data analysis aimed to answer the following research questions of the study:

1. What is the multiple intelligence profile of 6th grade students?
2. Is there a significant correlation between students' primary types of intelligence and their liking of the lesson activities?
3. Is there a significant correlation between students' primary types of intelligence and the effectiveness of learning from lesson activities as perceived by students?

The first question was answered by computing the primacy scores of each student for each type of intelligence based on their response to ten statements. These scores were then transformed into a bar graph depicting the profile of each student (see Figure 2). Further, average scores of primacy scores for each intelligence type were computed across the 14 students, which provided a picture of the distribution of the average primacy scores for each intelligence type for this sample of students.

For the second question, correlations between primacy scores for each intelligence type and the rating scores for attractiveness of each of the six activities were computed. Two intelligence types; naturalistic and musical were not included in the design of lesson activities because it was difficult to design math lesson activities for these two types of intelligences given the limited length of the lesson period. It was also the case that designing meaningful lesson activities for these types of intelligences were difficult. In this way, it was possible to see if there was a statistically significant correlation between primacy scores of the 14 students, for

example, interpersonal intelligence and their rating of the attractiveness of the activity that required use of an activity designed with an interpersonal context.

Similarly, for the third question, correlations between primacy scores for each intelligence type and the rating scores for the perceived facility of each activity to support individual learning were computed. These computations allowed evaluating whether there was a statistically significant correlation between primacy scores of the 14 students, for example, interpersonal intelligence and their rating of the perceived degree to which an activity designed with an interpersonal context supported students' learning. Because the sample size was small, a nonparametric method, Kendall's rho for correlation were computed using the *Statistical Package for Social Sciences SPSS version 18.0 (SPSS, 2009).*

CHAPTER 4: RESULTS

Demographic information about participants

The pre-intervention survey, which was conducted to identify students' MI profiles, had a cover page. On this page, students were asked to indicate their gender, their age, write in last year's end-of-year math grade, and to list their three favourite classes. In this section, student responses to these questions are summarized.

Out of 14 students, 8 were girls and 6 were boys. All of the participants were 6^{th} grade students with the average age of 11 years. Ten students' reported their math grade in last years' grade report as 5 out of 5. The other 4 students' math grades in their grade report were 4. This shows that students had a good mathematical background from the previous year.

Table 1 shows students' three favourite classes, rated from first to third. According to table P.E. (physical education) and art were the most favourite classes, math was the second favourite class and English was the third favourite class among the students. It is interesting that even though students seemed to have done well the previous year in mathematics class; it was the most favourite class for only one student.

Table 1
The most favourite classes as reported by 14 students

Class	The first Favourite	The second Favourite	The third favourite
Math	1	4*	4
Science	1	-	-
English	2	3	5*
Drama	1	3	2
P.E.	5*	1	1
Art	4*	3	
Religious	-	-	2

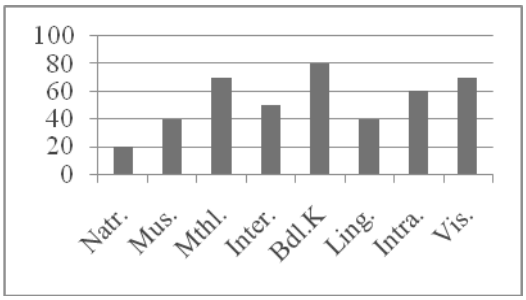
* stands for the highest number of students' liking of the classes

Multiple intelligence profile of 6th grade students

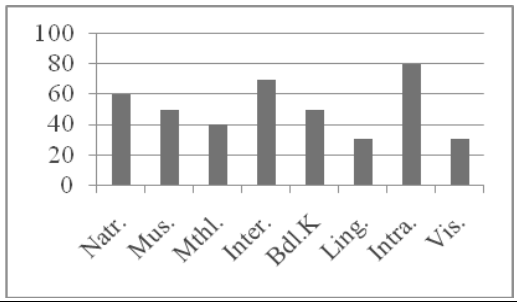
Data were collected from the participating 6th grade students using multiple intelligence survey (McKenzie, 1999) before the instructional intervention. Figure 2 gives the MI profile of the 14 students. Specific values for each intelligence type for a given student stand for the percentage of agreed statements out of 10 given in the survey.

Figure 2 shows that each student rated themselves as having variety levels of 8 different intelligences. This was in line with what Gardner (1999) would have predicted. According to Gardner, individuals most likely have all 9 different types of intelligences, though at varying levels of strength. Figure 2 shows that all of individuals have unique intelligence profiles.

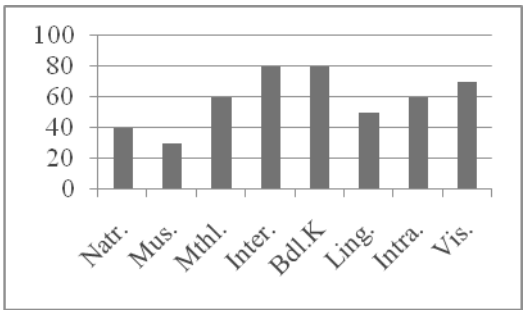
Student 1



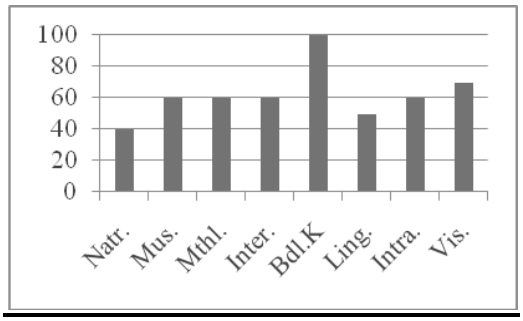
Student 2



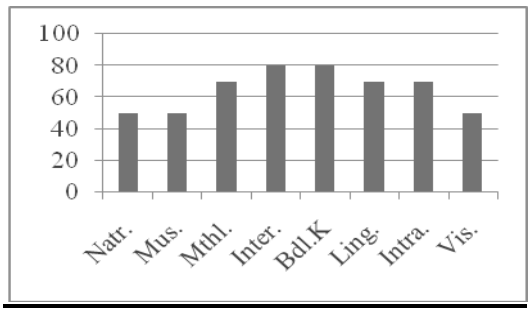
Student 3



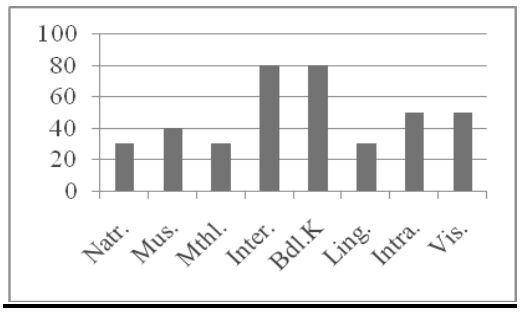
Student 4



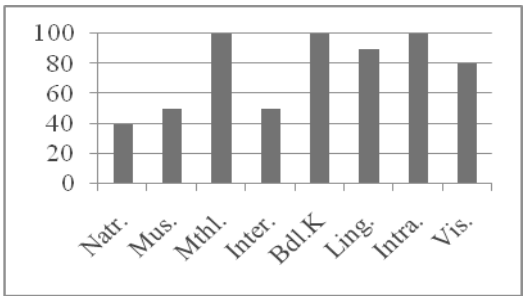
Student 5



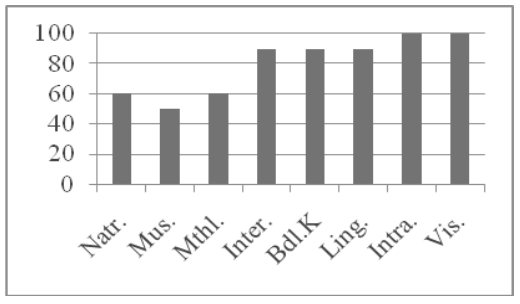
Student 6



Student 7



Student 8



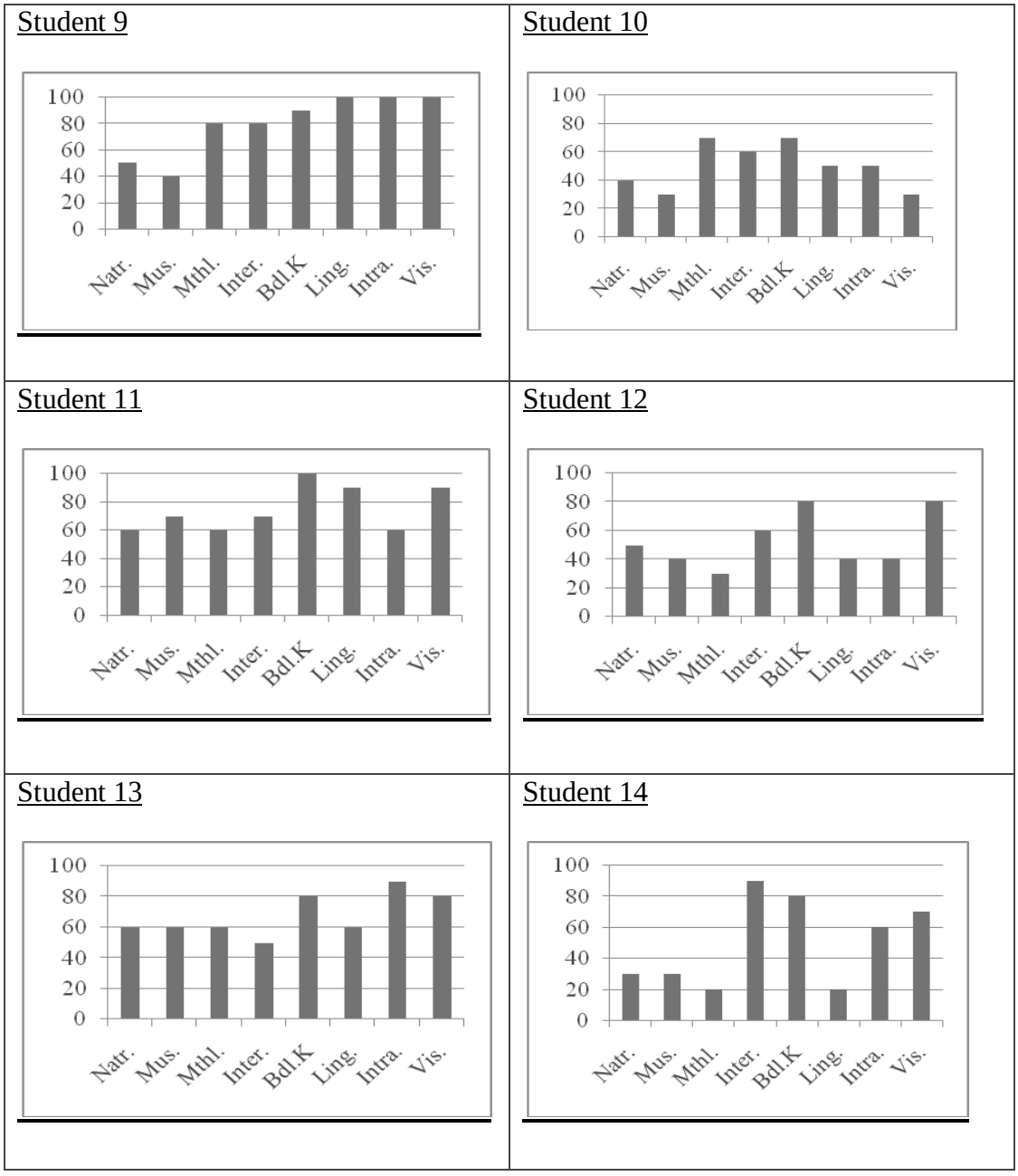


Figure 2. Multiple intelligence profiles of the 14 students

Next, average percentage scores for each intelligence type across the participating students were computed with the associated standard deviations. These scores are given in Table 2 and are shown in Figure 3.

Table 2
Average scores of 14 students' intelligence types with standard deviations

Types of Intelligence	Mean	Std. Deviation
Naturalistic	45.00	12.86
Musical	45.71	12.23
Mathematical	57.86	21.55
Interpersonal	69.29	14.39
Bodily-Kinesthetic	82.86	13.26
Linguistic	57.86	26.07
Intrapersonal	70.00	20.38
Visual	69.29	22.35

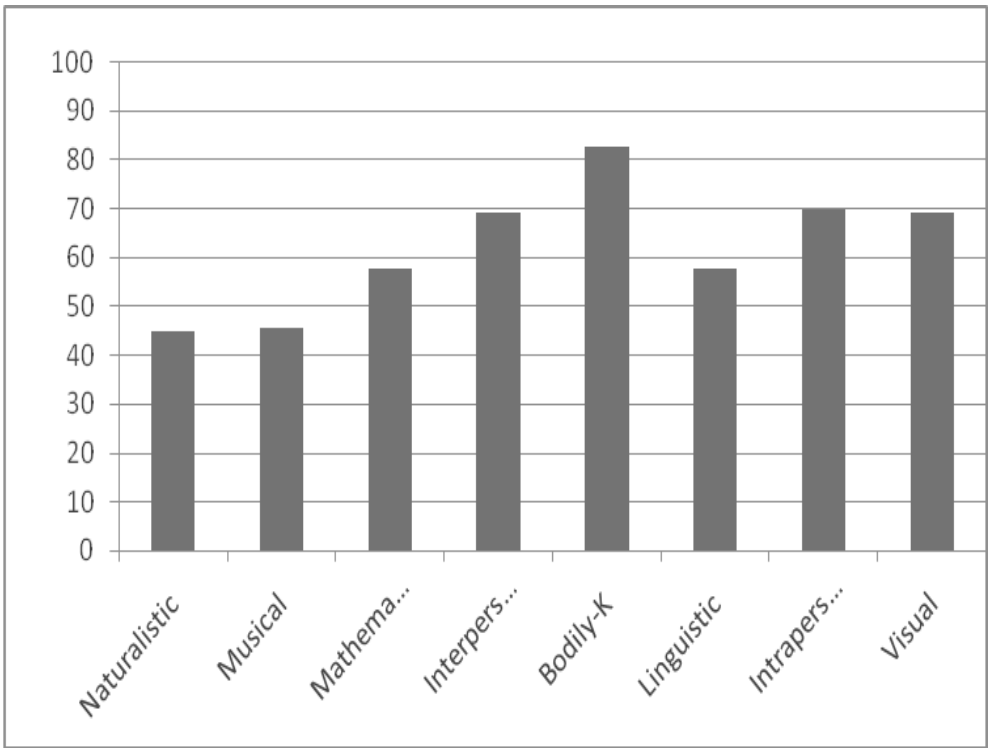


Figure 3. Average multiple intelligence scores of participants

The multiple intelligence survey consisted of statements about 8 different types of intelligences: naturalistic, musical, mathematical-logical, interpersonal, bodily-

kinesthetic, linguistic, intrapersonal and visual intelligences. The study actually focused on the following 6 intelligence types: mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences. Two intelligence types; naturalistic and musical were not included in the design of lesson activities because it was difficult to design math lesson activities for these two types of intelligences.

According to the results of the MI survey, which gives an indication of an individual's perceived MI preferences; the highest types of intelligence among the participants is bodily-kinesthetic intelligence with an average score of 83%. This shows that this group of 6^{th} grade students liked expressing ideas using their bodies and they preferred using their capacity to manipulate objects and using a variety of physical skills. Next visual, interpersonal and intrapersonal intelligences seem to have a relatively higher prevalence among these students with about 70% scores. This means that students had sensitivity to different colors, shapes and other visual elements around them. They preferred studying alone with the basic feeling of self-esteem and self-understanding. They also preferred interacting with other people when they were studying. Furthermore mathematical-logical and linguistic intelligences seem to have average prevalence among the participating students with about 57% scores. It shows that students prefer using their mathematical-logical and linguistic abilities at the average level.

When the correlation among the focused 6 intelligence types: mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences intelligences was examined, it was observed that there was a close relationship between some of these intelligences as depicted in Table 3.

Table 3
Correlations among different types of intelligences

Kendall's tau_b	Mathtl.	Inter-person	Bodily Kin.	Ling.	Intra-person	Visual
Mathematical		-.299	.252	**.588****	.390	.128
Interpersonal			-.028	-.050	.065	.064
Bodily-Kin.				**.513***	.295	**.609****
Linguistic					**.513***	**.543***
Intrapersonal						.359
Visual						

* stands for statistical significance at .05 level
** stands for statistical significance at .01 level

Table 3 shows that there are statistically significant inter-intelligence correlations between mathematical and linguistic, bodily-kinesthetic and linguistic, bodily-kinesthetic and visual, linguistic and intrapersonal and linguistic and visual types of intelligences. It is interesting to note that there is a negative although not significant correlation between mathematical-logical and interpersonal intelligences. The only intelligence type that is not correlated with any other type of intelligence is interpersonal intelligence.

Correlation between multiple intelligence types and reported liking of lesson activities

Correlations were computed between each intelligence types and the liking ratings of lesson activities. Results are given in table 4. Significant correlations between all lesson activities and mathematical intelligence types were observed with the exception of lesson activity that highlighted bodily-kinesthetic intelligence.

Table 4
Correlations between perceived liking of lesson activities and MI types

	PL1*** *(Ling. Act.)*	PL2 *(Vis Act.)*	PL3 *(Intra. Act)*	PL4 *(Inter. Act.)*	PL5 *(B.K. Act.)*	PL6 *(Math Act.)*
Mathl.Int.	.570**	.504*	.643**	.680**	.348	.726**
InterP.Int.	-.025	-.098	-.124	.012	.236	-.138
B.K.Int.	.410	.159	.507*	.307	.376	.486*
Ling.Int.	.695**	.414	.679**	.738**	.491*	.627**
IntraP.Int	.544*	.123	.408	.396	.187	.463*
Vis.Int	.500*	-.024	.427*	.366	.282	.346

* stands for statistical significance at .05 level
** stands for statistical significance at .01 level
*** PL: perceived liking

Second, linguistic intelligence was correlated with all lesson activities except the lesson activity that highlighted visual intelligence. These two findings show that students with higher mathematical-logical and linguistic intelligences tend to like most of the mathematics lesson activities that addressed different types of intelligences. Interestingly interpersonal intelligence had moderate negative correlations (though not significant) with liking the lesson activities. In other words, students with pronounced interpersonal intelligence tended to seem to have the least liking of mathematical-logical lesson activities.

Looking at the other perspective, liking lesson activities with visual and bodily-kinesthetic components did not correlate with the reported primacy of intelligence types, except visual activity with mathematical-logical intelligence and bodily-kinesthetic activities with linguistic intelligence. This shows that in math lessons most students tend to have less liking of these two types of lesson activities.

Correlations between students' intelligence types and the effectiveness of learning from the lesson activities as perceived by students

Similarly, correlations were computed between each intelligence type and the perceived effectiveness ratings of lesson activities. Table 5 shows the correlations between perceived effectiveness of lesson activities and intelligence types.

Table 5
Correlations between perceived effectiveness of lesson activities and intelligence types

	PE1*** *(Ling. Act.)*	PE2 *(Vis Act.)*	PE3 *(Intra. Act)*	PE4 *(Inter. Act.)*	PE5 *(B.K. Act.)*	PE6 *(Math Act.)*
Mathl.Int.	.450*	.627**	.619**	.705**	.494*	.450*
InterP.Int.	.100	-.086	-.013	-.115	.025	.100
B.K.Int.	.432	.226	.390	.332	.360	.547*
Ling.Int.	.627**	.663**	.609**	.815**	.738**	.550*
IntraP.Int	.438*	.504*	.490*	.462*	.507*	.429
Vis.Int	.506*	.328	.369	.354	.500*	.436*

* stands for statistical significance at .05 level
** stands for statistical significance at .01 level
*** perceived effectiveness

The most prominent finding is that students with higher mathematical-logical intelligence tended to perceive a higher effectiveness of lesson activities regardless of the type of the lesson activity. Similarly students with higher linguistic intelligence tended to see a bigger benefit in the lesson activities no matter what the type of activity was. On the other hand, students with a more pronounced interpersonal intelligence tended to perceive relatively less benefit from the mathematical-logical lesson activities. This was true even for the activity that highlighted interpersonal skills.

CHAPTER 5: DISCUSSION

Introduction

This chapter gives a discussion of the findings, and interpretations of the findings are attempted by connecting with research literature. Implications for practice and suggestions for further research are also given.

Discussion of findings

According to the results of individual MI profiles, it is clear that each student has a different pattern of the primacy of intelligence types (see Figure 2). In fact Gardner (1999) predicted that every individual has some aspects of naturalistic, musical, mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences and that an individual does not need to reflect only one type of intelligence. In this study, it was found that the most dominant intelligence type among participants was bodily-kinesthetic intelligence. The next common intelligence types were visual intelligence, intrapersonal intelligence and interpersonal intelligence with about 70 percentages approximately (see Figure 3).

Additionally as part of the MI survey, students were asked to rate their favorite class from 1 to 3. Most students indicated that P.E. and Art were their favorite classes (see Table 1). This finding seemed to further support the notion that most students have bodily-kinesthetic as their primary types of intelligence. We can infer that at age 11, students prefer active physical involvement during their learning, although it may not necessarily be the most effective way to learn mathematics. Games and activities are

still important parts of 11 years old students' life. They enjoy moving around and touching things. Fifth and sixth grade students expect tactile and kinesthetic learning materials during the lessons (Holt et al., 2007).

There was a strong relationship also between students' age and their learning preferences. Students are between childhood and adolescence in the 6th grade. At this age their concrete thinking may be more prominent. During adolescence, students' abstract thinking skills are developed and they prefer more challenging lesson activities different from visual and tactile materials. Self-learning and self-awareness are adolescents' strongest characteristics (TPYAL, 2004). Since 6th grade students are at the concrete thinking level, they may need to learn mathematics visually and kinesthetically. In this study, one of the most common intelligence types among participants was found to be intrapersonal intelligence. It shows that students may also require studying individually in a quiet learning atmosphere while learning mathematics.

Implications of findings for understanding the theory of multiple intelligences

Among the six types of intelligences studied in this research, linguistic intelligence and mathematical-logical intelligence are correlated highest among themselves (see Table 3). For the purpose of understanding general intelligence, linguistic and mathematical-logical intelligences seem to be most crucial. This may also explain why most commercial tests designed to predict academic aptitude such as SAT (scholastic aptitude test) have two primary components: verbal and quantitative. Students with developed linguistic intelligence communicate to others orally and in writing in a fluent way and they take notes well. Additionally, they like listening to others carefully and have the ability to comprehend what others say. Therefore

linguistic intelligence may support mathematical-logical intelligence to communicate mathematical knowledge. Mathematical expression is essential for students to learn efficiently and it depends on the linguistic abilities of learners (Sousa, 2008).

According to the findings reported earlier about the correlation between the 6 types of intelligences, there are statistically significant inter-intelligence correlations between bodily-kinesthetic and visual intelligence types (see Table 3). This may be due to the fact that bodily-kinesthetic and visual intelligences have some common characteristics. For example, drawing something has both visual and tactile components.

Interestingly, this study showed that there is considerable correlation between linguistic and intrapersonal intelligence types (see Table 3). Linguistic intelligence has effects on intrapersonal intelligence as it may require self-consciousness. Since intrapersonal students' self-reflective abilities are relatively well-developed, it may support linguistic ability positively as self-expression is also part of linguistic ability.

About increasing student motivation and implications for teaching mathematics

When the Table 4 and 5 which were about correlations between students' perceived liking and perceived effectiveness of lesson activities and MI types were examined, it was observed that activities directed to mathematical-logical and linguistic intelligences were observed to be the most effective activities for learning mathematics. The reader will remember that correlations were computed between each intelligence type and the perceived effectiveness ratings of lesson activities. The most significant finding was that students with higher mathematical-logical and linguistic intelligences tended to perceive a higher effectiveness of lesson activities

regardless of the type of the lesson activity. This showed that learning mathematics is probably most supported by linguistic and mathematical-logical abilities.

Significant correlations between all lesson activities and mathematical intelligence were observed with the exception of lesson activities that highlighted bodily-kinesthetic intelligence (see Table 4). It is interesting to observe that the dominant MI type among students was bodily-kinesthetic intelligence however there is no significant correlation between mathematical-logical intelligence and activities that tapped into bodily-kinesthetic intelligence among students. This shows that learning mathematics depends on mathematical-logical activities such as calculation, classification, problem solving activities and linguistic activities such as discussions, writing, listening to others.

Interestingly interpersonal intelligence type had moderate negative correlations (though not significant) with liking the lesson activities (see Table 4). In other words, students with dominant interpersonal intelligence tended to seem to have relatively the least liking of mathematical lesson activities. Interpersonal lesson activities helped students develop communication with their peers, share ideas and establish cooperative learning skills (Işık & Tarım, 2005). This study showed that group working activities may be enjoyable for students; however, it is probably not an efficient way of learning mathematics especially for 6^{th} grade students. Group working activities seemed like playing games and meeting classmates. According to this study, learning math is basically supported by mathematical expressions, listening, writing, solving problems, categorizing ideas in a quiet learning environment. Sixth grade students prefer learning mathematics individually, and too

many interpersonal activities may disrupt their learning of mathematics in a classroom (Holt et al., 2007).

Furthermore another interesting finding of this study was that students with higher mathematical-logical intelligence tended to perceive a higher effectiveness of lesson activities regardless of the type of lesson activity. Similarly students with higher linguistic intelligence tended to see a bigger benefit in the lesson activities no matter what the type of the activity was (see Table 5). On the other hand, students with a more pronounced interpersonal intelligence tended to perceive relatively less benefit from the mathematical lesson activities. This was true even for the mathematical activity that highlighted interpersonal skills. Differently from the correlation table of liking the lesson activities, intrapersonal intelligence type tended to see considerable benefit in the lesson activities no matter what the type of the activity was. It shows that 6th grade students can benefit from working individually and calmly to comprehend the related mathematics topic.

Implications for practice

In education, dominant types of intelligences may imply students' primary learning preferences for learning. Planning the lessons by taking care of students' MI profiles is one way to create an effective learning atmosphere for teachers. Students are motivated and feel themselves as part of the lesson when they meet activities based on their primary MI types. The good news for teachers is that even though students may have their own unique dominant type of intelligence, they may still like and can benefit from lesson activities that highlight other intelligence types as well. This is more true for students with dominant mathematical-logical and linguistic

intelligences, and less so for students with dominant interpersonal intelligences, according to the findings of this study.

Distribution of intelligence types among students can give teachers ideas about which lesson activities will work for their students. It is essential for teachers to know common MI types in their classrooms to help them realize ways of reaching every student during lesson. Since MI theory is a way to discover students' learning abilities, teachers may plan efficient lesson activities with better learning outcomes.

The way of teaching mathematics addressing the focused 6 types of intelligences; mathematical-logical, interpersonal, bodily-kinesthetic, linguistic, intrapersonal and visual intelligences should be considered by teachers to meet different needs of students in the classroom. Students with dominant linguistic intelligence prefer verbal activities while learning. Therefore it is best to create discussion sessions while teaching mathematics to let students express their mathematical knowledge in words (Gürel & Tat, 2010). During this study, linguistically intelligent students needed to see mathematics in a written form on the board. Taking notes is effective for their learning. Therefore teachers should give time for students to take notes and give them the opportunity to explain mathematics in words.

Students with dominant mathematical-logical intelligence are keen on problem solving and working with numbers. These students like interpreting mathematical terminologies abstractly and tend to think critically on their own. Teachers may ask Socratic questions for students to help them discover mathematical knowledge. Some logic games which are challenging may motivate mathematical-logical students at the beginning of mathematics lessons.

Students with dominant visual intelligence have a potential to comprehend the objects around them 3-dimensionally which allows them to reflect on their knowledge visually (Gardner, 1993). Visual intelligent learners in this study liked integrating mathematics with arts. They enjoyed mathematical pictures, graphs, maps and videos related to the topic during learning mathematics. Sixth grade students especially like visual lesson materials which help them create images of the mathematical concepts in their minds (Holt et al., 2007).

Students with dominant bodily-kinesthetic intelligence liked tactile activities such as moving around and building tools. They enjoyed hands-on materials. "There is a need to touch and manipulate in order to gain understanding and a need for muscle memory and control of blended voluntary and automatic movements" (Campbell, et al., 1999). Bodily-kinesthetic learners are good at expressing themselves physically so teachers should guide students to be aware of their physical potential.

Students with dominant interpersonal intelligence like social interactions. Sharing ideas with others and working cooperatively make them enjoy learning. Teachers may arrange group work activities for students to let them develop empathy with each other. Listening and speaking with peers help students develop leadership and organisation skills as well (Armstrong, 2009).

Finally students with dominant intrapersonal intelligences have the ability to evaluate themselves and they are aware of their own strengths and weaknesses. Self-esteem is the basic characteristics of intrapersonal individuals. Intrapersonal learners prefer studying alone and developing the knowledge inside through self-consciousness. Teachers may provide individual working sessions for intrapersonal students (Armstrong, 2009).

In general "interest in mathematics, efficiency in performing mathematics tasks, motivation and pleasure with mathematics, and self-concept all affect learning mathematics" (Ignacio et al., 2006, p.18). If teachers can provide learning experiences for students that facilitate their learning in mathematics in an optimal way and commensurate with their learning needs, students may have improved attitudes towards mathematics and increased achievement in mathematics. It is hoped that this study will provide additional insights to teachers in this regard.

Suggestions for further research

This study showed that each student has a different pattern of intelligence. However MI types which reflect students' ability to learn do not have to be determined by using the MI survey only, which is based on self-declaration. Observation is also essential for teachers to identify what type of intelligences students have. Future studies can consider supplementing MI survey by teacher observation to identify students' primary types of intelligence.

Additionally, learning mathematics is more meaningful for students with linguistic and mathematical intelligences since students may be more familiar with these types of activities in Turkish schools. Future studies should explore the relationship between learning preferences of students and familiarity of mathematical activities preferred by teachers. Future studies should also investigate the effects of teaching preferences of teachers on learning preferences of students.

Limitations

This study has some limitations that might have affected its results. Students were selected from a private middle school where the students were familiar with different teaching tools. Therefore the conditions for public schools may be somewhat different; caution should be exercised while generalizing findings to public school contexts.

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APPENDICES

Appendix A: Multiple Intelligence Survey

Part I

Complete each section by placing a "1" next to each statement you feel accurately describes you. If you do not identify with a statement, leave the space provided blank. Then total the column in each section.

Section 1

_____ I enjoy categorizing things by common traits

_____ Ecological issues are important to me

_____ Classification helps me make sense of new data

_____ I enjoy working in a garden

_____ I believe preserving our National Parks is important

_____ Putting things in hierarchies makes sense to me

_____ Animals are important in my life

_____ My home has a recycling system in place

_____ I enjoy studying biology, botany and/or zoology

_____ I pick up on subtle differences in meaning

_____ TOTAL for Section 1

Section 2

_____ I easily pick up on patterns

_____ I focus in on noise and sounds

_____ Moving to a beat is easy for me

_____ I enjoy making music

_____ I respond to the cadence of poetry

_____ I remember things by putting them in a rhyme

_____ Concentration is difficult for me if there is background noise

_____ Listening to sounds in nature can be very relaxing

_____ Musicals are more engagingto me than dramatic plays

_____ Remembering song lyrics is easy for me

_____ TOTAL for Section 2

Section 3

_____ I am known for being neat and orderly

_____ Step-by-step directions are a big help

_____ Problem solving comes easily to me

_____ I get easily frustrated with disorganized people

_____ I can complete calculations quickly in my head

_____ Logic puzzles are fun

_____ I can't begin an assignment until I have all my "ducks in a row"

_____ Structure is a good thing

_____ I enjoy troubleshooting something that isn't working properly

_____ Things have to make sense to me or I am dissatisfied

_____ TOTAL for Section 3

Section 4

_____ I learn best interacting with others

_____ I enjoy informal chat and serious discussion

_____ The more the merrier

_____ I often serve as a leader among peers and colleagues

_____ I value relationships more than ideas or accomplishments

_____ Study groups are very productive for me

_____ I am a “team player”

_____ Friends are important to me

_____ I belong to more than three clubs or organizations

_____ I dislike working alone

_____ TOTAL for Section 4

Section 5

_____ I learn by doing

_____ I enjoy making things with my hands

_____ Sports are a part of my life

_____ I use gestures and non-verbal cues when I communicate

_____ Demonstrating is better than explaining

_____ I love to dance

_____ I like working with tools

_____ Inactivity can make me more tired than being very busy

_____ Hands-on activities are fun

_____ I live an active lifestyle

_____ TOTAL for Section 5

Section 6

_____ Foreign languages interest me

_____ I enjoy reading books, magazines and web sites

_____ I keep a journal

_____ Word puzzles like crosswords or jumbles are enjoyable

_____ Taking notes helps me remember and understand

_____ I faithfully contact friends through letters and/or e-mail

_____ It is easy for me to explain my ideas to others

_____ I write for pleasure

_____ Puns, anagrams and spoonerisms are fun

_____ I enjoy public speaking and participating in debates

_____ TOTAL for Section 6

Section 7

_____ My attitude effects how I learn

_____ I like to be involved in causes that help others

_____ I am keenly aware of my moral beliefs

_____ I learn best when I have an emotional attachment to the subject

_____ Fairness is important to me

_____ Social justice issues interest me

_____ Working alone can be just as productive as working in a group

_____ I need to know why I should do something before I agree to do it

_____ When I believe in something I give more effort towards it

_____ I am willing to protest or sign a petition to right a wrong

_____ TOTAL for Section 7

Section 8

____ I can visualize ideas in my mind

_____ Rearranging a room and redecorating are fun for me

_____ I enjoy creating my own works of art

_____ I remember better using graphic organizers

_____ I enjoy all kinds of entertainment media

_____ Charts, graphs and tables help me interpret data

_____ A music video can make me more interested in a song

_____ I can recall things as mental pictures

_____ I am good at reading maps and blueprints

_____ Three dimensional puzzles are fun

_____ TOTAL for Section 8

Part II

Now carry forward your total from each section and multiply by 10 below: Section	Total Forward	Multiply	Score
1		X10	
2		X10	
3		X10	
4		X10	
5		X10	
6		X10	
7		X10	
8		X10	

Section 1 – This reflects your Naturalist strength

Section 2 – This suggests your Musical strength

Section 3 – This indicates your Logical strength

Section 4 – This shows your Interpersonal strength

Section 5 – This tells your Kinesthetic strength

Section 6 – This indicates your Verbal strength

Section 7 – This reflects your Intrapersonal strength

Section 8 – This suggests your Visual strength

Appendix B: Self-reflection Form

Self-reflection form I	
Lesson Activity I – Linguistic Activity	
1	Describing the types of angles by using my own words.
2	Taking notes regularly during the lesson.
3	Listening to my friends' and teacher's speeches.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 1, 2 and 3 by using your own words in the given blanks below:**
<u>1, 2 and 3. Activities during the lesson:</u> • Were very attractive • Were attractive. • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	
Lesson Activity II – Visual Activity	
4	Watching a video – introducing types of angles
5	Learning how to use protractor with an interactive applet-by reflecting on the board.
6	Introduction of angles with colorful cartons on the board.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 4, 5 and 6 by using your own words in the given blanks below:**
<u>4, 5 and 6. Activities during the lesson:</u> • Were very attractive • Were attractive. • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	

Lesson Activity III – Intrapersonal Activity	
7	Studying individually on the given worksheet about the video "types of angle "and complete it successfully.
8	Solving "angles of the hand of time" worksheet individually by using my protractor.
9	Evaluating my own learning process during the lesson.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 7, 8 and 9 by using your own words in the given blanks below:**
<u>7, 8 and 9. Activities during the lesson:</u> • Were very attractive • Were attractive. • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	
Lesson Activity IV – Bodily-Kinesthetic Activity	
10	Using the protractor to measure the size of an angle.
11	Using my body and moving in the classroom to show the given type of an angle.
12	Taking part in activities by moving physically.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 10, 11 and 12 by using your own words in the given blanks below:**
<u>10, 11 and 12. Activities during the lesson:</u> • Were very attractive • Were attractive. • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	

Lesson Activity V – Interpersonal Activity	
13	Discussing lesson activities as a group during group working activity.
14	Deciding how to illustrate the given task-types of angles- as a group.
15	Presenting "type of an angle" as a group cooperatively.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 13, 14 and 15 by using your own words in the given blanks below:**
13, 14 and 15. Activities during the lesson: • Were very attractive • Were attractive. • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	
Lesson Activity VI – Mathematical – Logical Activity	
16	Solving given mathematics problems during the lesson.
17	Measuring the size of an angle and complete the given tasks successfully.
18	Describing geometrical figures and applying this knowledge on solving problems.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 16, 17 and 18 by using your own words in the given blanks below :**
16, 17 and 18. Activities during the lesson: • Were very attractive • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	

ACTIVITY	***I LEARNED THE TOPIC WITH THIS ACTIVITY EFFICIENTLY*** ***(mark from 1 to 10)***	***IT WAS ATTRACTIVE*** ***(Mark from 1 to 10)***
Describing types of angles by using my own words.		
Watching a video “types of angles”.		
Working individually on the given worksheets.		
Working in groups and sharing different ideas.		
Creating types of angles by using our bodies.		
Solving math problems on the given worksheet.		

Self-reflection Form II	
Lesson Activity I – Linguistic Activity	
1	Describing the types of triangles by using my own words.
2	Working on "fill in the blanks" worksheet.
3	Listening to my friends' and teacher's speeches joining classroom discussions.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 1, 2 and 3 by using your own words in the given blanks below:**
1, 2 and 3. Activities during the lesson: • Were very • Were attractive. • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	
Lesson Activity II – Visual Activity	
4	Watching a video – introducing types of triangles
5	Watching Real-Life pictures of quadrilaterals.
6	Introduction of triangles with colorful papers.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 4, 5 and 6 by using your own words in the given blanks below:**
4, 5 and 6. Activities during the lesson: • Were very attractive • Were attractive. • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	

Lesson Activity III – Intrapersonal Activity	
7	Studying triangles exercises individually - successfully.
8	Studying parallel-lines worksheets individually successfully.
9	Evaluating my own learning process during the lesson.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 7, 8 and 9 by using your own words in the given blanks below:**
<u>7, 8 and 9. Activities during the lesson:</u> • Were very attractive • Were attractive. • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	
Lesson Activity IV – Bodily – Kinesthetic Activity	
10	Cutting triangles and getting 180 degree.
11	Moving in the classroom to show angles between big carton transversal and parallel lines in the center of the classroom.
12	Sticking the given colorful paper triangles on the types of triangle worksheet.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 10, 11 and 12 by using your own words in the given blanks below:**
<u>10, 11 and 12. Activities during the lesson:</u> • Were very attractive • Were attractive. • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	

Lesson Activity V – Interpersonal Activity	
13	Discussing lesson activities as a group during group working activity.
14	Deciding how to classify quadrilaterals as a group.
15	Working cooperatively helped me to learn the topic during the lesson.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 13, 14 and 15 by using your own words in the given blanks below:**
13, 14 and 15. Activities during the lesson: • Were very attractive • Were attractive. • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	
Lesson Activity VI – Mathematical – Logical Activity	
16	Solving given mathematics problems during the lesson.
17	Finding the size of the missing angles and completing the given tasks successfully.
18	Describing geometrical figures and applying this knowledge on solving problems.
Please choose one of the statements below to describe your learning during the lesson and circle it.	**Please describe your learning during the activities 16, 17 and 18 by using your own words in the given blanks below :**
16, 17 and 18. Activities during the lesson: • Were very attractive • Were attractive • I do not remember the activities • Were not attractive. • Were not attractive and I could not understand the topic.	

ACTIVITY	***I LEARNED THE TOPIC WITH THIS ACTIVITY EFFICIENTLY*** ***(mark from 1 to 10)***	***IT WAS ATTRACTIVE*** ***(Mark from 1 to 10)***
Describing mathematical knowledge with “fill in the blanks” parts.		
Watching a video “types of triangles”.		
Working individually on the given worksheets.		
Working in groups and sharing different ideas.		
Cutting and sticking different triangles during the lesson.		
Solving math problems on the given worksheet.		

Appendix C: Lesson Plan Sample

LESSON PLAN

Student-Teachers: Begüm YILMAZ **Date of lesson:** 15 November 2011
No. of students: 15

Length of lesson: 40 + 40 minutes

Grade of level: 6th grade

Topic: Types of Angles & Discovering more about Angles

Learning Objectives: Students will

- Review key-terms in the previous lesson (angle, measuring the angle)
- Realize how to measure the size of an angle by the help of an interactive applet.
- Use protractor to measure the size of an angle
- Define the size of an angle with the unit "degree" and the symbol "°".
- Solve the exercises from textbook individually by using their protractor.
- Define the types of angle by themselves while watching a video.
- Discover the characteristics of types of angles by filling in the blanks on the given table.
- Make connection with real-life about types of angles by giving real-life examples.
- Work cooperatively and share different ideas with each other.
- Use their body to illustrate the given type of angle as a group.
- Prepare a poster to describe their type of angle attractively.
- Make presentation by using their body and posters.

Assessment Strategies: Direct questions during the lesson, problem solving on the given worksheet, the skills of applying manipulative and their performance on mathematical expression.

Materials: computer, internet, board, pencils, colorful papers, pencils, colorful cartoons and protractor

Time	Content	Teacher's activity	Student's activity
1'		Greeting, Checking attendance	
5'	Review **(Linguistic intelligence activity)**	Teacher asks questions about the geometrical terms which are learned in the previous lesson. Teacher solves some naming angles exercises on the board with students to be sure they understand correctly. While solving exercises, teacher reviews key terms of the previous lesson and asks students questions.	
10'	Measuring the Size of an Angle **(Linguistic intelligence activity)**	Teacher draws different angles on the board and asks; • Which angle is larger? • How do you decide which angle is bigger? • How can we measure the size of an angle? Teacher explains that angles are used to measure turning and **protractor** is the instrument to measure the size of an angle. The unit of measurement is degree "°". Teacher takes one of the students in the classroom to the board and takes a complete turn around him/her. She explains that angles are used to measure how far something has turned. She draws and writes on the board: a complete turn= 360˚	
10'	Measuring the size of an angle **Visual intelligence activity**	Teacher takes a half turn and a quarter turn around the student and asks the angle size of these movements. She writes on the board: a half turn = 180˚, a quarter (1/4) turn= 90˚. Teacher uses an **interactive applet (http://www.amblesideprimary.com/ambleweb/mentalmaths/protractor.html)** to show how to use protractor to measure the size of an angle. She shows using protractor step by step and asks students some questions by using applet. Teacher shows students how to draw angle of size by using protractor.	

15’	Working individually **(Intrapersonal intelligence activity)**	Then teacher wants students work individually on Exercise 10:03 questions: 1 (c, e), 3 (c, d) and 4 (a, c). Students take notes and answer the questions which teacher asks. They follow teacher while she is showing an interactive applet to show how to use protractor. Then students work on Exercise 10:03 individually and ask questions if they need.
25’	Types of Angles (**Interpersonal intelligence activity and Bodily-Kinesthetic intelligence)**	Teacher gives cards for students; card A, card B, card C and card D that there are 4 students with card A, 4 students with card B, 4 students with card C and 3 students with card D. Firstly, groups of students A-B-C-D come together and discuss about their fill in the blanks table, they check their answers. As a group they give real-life examples for each types of angle and write them on the given paper. They have 5 minutes for this session. Then teacher wants each students to mention their findings and fills in the table by reflecting to the board. Secondly, student A’s come together, similarly students B, C, D come together with their new groups. During this session students have a mission; • Students named as A: obtuse angle • Students named as B: acute angle • Students named as C: right angle • Students named as D: straight angle Each group will work on their angle type and present it in an attractive and kinesthetic way. During presentation: - Students should use their body to illustrate their type of angle - Write the characteristics and real-life examples of their angle on the given card as a poster. - Try to make their poster attractive that after presentations each poster will be hanged in the classroom - Work cooperatively and use their time efficiently. Next, students present their performance to the classroom that each group has 2-minutes for presentation. At the end of this session teacher summarize what students have done.

10’	Solving problems **(Mathematical intelligence activity)**	Teacher distributes worksheet “angles and the hands of time” which is about types of angles. She expects students solve them individually and she walks around the students. Teacher helps students if they need any help. Students use their protractor to measure the size of the angles in the worksheet.
4’	Summarize the lesson	Teacher asks students quick questions based on mathematical terms which students learn during the day.