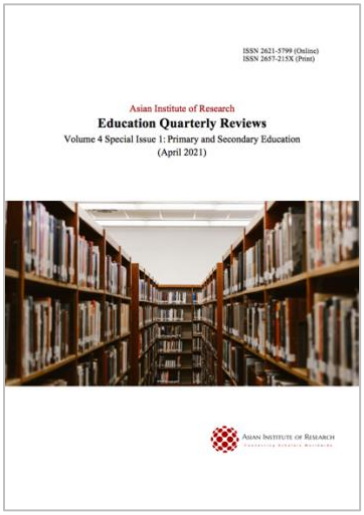

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Music and Mathematics: The Effect of Matching Musical Meters with Geometric Shapes on 6th Graders' Learning Outcomes

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Abstract
Aksak meters such as 5/8, 7/8, 9/8 are not formed equally and teaching these meters to the students usually takes a long time and learning these measures requires a dedicated effort. The aim of this research is to determine whether the teaching 5/8,7/8,9/8 aksak meters to the students in sixth grade through geometric shapes is more effective than regular techniques used in the music lesson. The research group was composed of 120 sixth grade students between ages 11-14 in one private and one public school in Ankara. The research was composed in randomized pre-test, post-test control group experimental design. During 8 weeks teaching aksak meters through matching musical meters to geometrical shapes technique was practiced with the experimental group. The data was analyzed on the IBM SPSS Statistics 22 Program. Mc Nemar test was used for the dependent relationship between two categorical variables. According to findings of this research, students in the experimental group scored higher points in their post-test than students in the control group and improved their efficacy in distinguishing the aksak measures. This shows that teaching aksak Meters through geometric shapes affected students' learning outcomes in a positive way.

Keywords: Music and Mathematics, Aksak Meters, Geometric Shapes, Music Education, Teaching

1. Introduction

Mathematics and music have been compared and associated with each other since ancient era. Many mathematicians and philosophers have studied on this subject since then. Pythagoras, Plato and Aristotle, wrote about the overlaps and links between the two disciplines (Bamberger and Disessa, 2003; Azaryahu et al. 2019) Furthermore, in the middle age music was considered as a sub major of mathematics. In those days mathematics was divided into two sub majors; theoretical and applied mathematics. Arithmetic and geometry were considered to be in the theoretical mathematics sub major and astronomy and music were considered to be in the applied

mathematics sub major. Now days mathematics and music are described as universal languages and two ways of expressing patterns of human rational thoughts and emotional feelings (Nagy et al., 2020). These two universal languages are interrelated, as Papadopoulos (2002) states mathematics and music are similarly expressed through the use of representational language and symbolic notations (Papadopoulos, 2002). More specifically musical elements such as melody, rhythm, intervals, scales, harmony, and tuning are related to mathematical concepts such as numerical relations, proportions, integers, logarithms, arithmetical operations, trigonometry, and geometry (Beer, 1998; Harkleroad, 2006; An et al. 2013).

Related Literature

There are many studies which show that music education provided by the family in the early childhood period (singing songs with family members, listening to self music archives, practicing rhythm, etc.) enhances the mathematic skills of the individuals. Accordingly the relationships between mathematics and music have been researched broadly, and research has suggested that music can enhance students' academic outcomes in mathematics (An et al., 2016; Evans, 2009; Harris, 2005; Nisbet, 1998; Rauscher, 2003; Schumacher et al., 2006; Still and Bobis, 2005; Spychiger, 2001; Vaughn, 2000; Nagy et al., 2020).

Researchers have also pursued a line of inquiry into outcomes for students resulting from including music activities in mathematics instruction (e.g., An et al., 2008; Benes-Laffety, 1995; Omniewski, 1999). These studies have provided empirical evidence that music has the potential to improve students' mathematics achievement and attitudes (An et al., 2013). The existing literature shows that learning to play a musical instrument has proven to have positive effects on mathematics achievement (An et al**.,** 2013). As Helmrich (2010) points out, music supports creativity, problem solving, and diverse thinking skills needed in mathematical learning, particularly algebra (Gonzales, 2017).

In 2015, Cranmore and Tunks in a case study explored high school students' perceptions on how mathematics and music are related. Their results showed that 14 out of 24 high school students perceived cognitive connections between mathematics and music and students emphasized that mathematics skills were crucial for understanding music (Cranmore and Tunks, 2015). While Cranmore and Tunks' (2015) research findings indicate that mathematics support music ability, research that observed the relationship between music and mathematics suggest that music training supports mathematics ability (Helmric, 2010; Ivanov and Geack, 2003, Kinney, 2008; Shore, 2010; Gonzales, 2017). Similarly according to Shilling (2002) studies also show that, mathematics and music are actually relevant to each other and can feed and enhance each other speaking in a manner of learning any of them (Shilling, 2002). Since music has the potential to improve students' mathematical achievement and attitudes, the same effect can be seen in the opposite direction. In other words, mathematical methods can make some incomprehensible musical concepts understandable. In this context, in this study we tried to use the same approach but in the opposite direction and used mathematical methods to make some incomprehensible musical concepts understandable for students.

Simple and Aksak Meters

In music lessons, students learn numerous abstract musical concepts, such as rhythmic and melodic notation, conversion in key and time, diverse instrument playing techniques etc. Most of these musical skills are infused with mathematics because there are based on patterns that can be easily predicted by students (Courey et al., 2012; Gonzales, 2017). For example rhythm is among the most basic mathematical concepts in music theory. The link to mathematics is obvious: a numerical pattern of beats, which can be counted, bears direct resemblance to the study of basic arithmetic (James, 1991). In Turkey teaching rhythm and more specifically music meters is a part of 6^{th} grade music lesson curriculum the curriculum includes simple meters and aksak meters. Meter is a repetitive pattern that provides the beat or pulse of music. Meter is notated at the beginning of the music pieces with a time signature. Time signatures are always notated with two numbers, one on top of the other, much like a fraction in math. While the top number represents the number of beats in each measure, the bottom number represents the note value that receives the beat. There are different categories of meter such as simple,

compound, or aksak. Each of the categories of meter is defined by the subdivision of beats. The number of beats for a measuredefinese the term associated with that meter.

In this study we used the approach from easy to more difficult. We started with simple meters which are the easiest meters 2/4, 3/4 and 4/4. Which can be shown as 2/4= (1+1) = 2 beats in total for a measure, 3/4= (1+1+1) = 3 beats in total for a measure and 4/4=(1+1+1+1) = 4 beats in total for a measure. When it comes to aksak meter it is more complicated. Aksak is a rhythmic organization used broadly in Turkish music. Goldberg (2015) in his study stated that ''Other terms that have been applied to aksak are additive rhythm, "unequally divided meter," and nonisochronous meter (Sachs, 1953; Dzhudzhev, 1980; London, 2012). While the theoretical approaches corresponding to these names differ substantially from one another, they typically describe temporal cycles composed of durations belonging to two different categories, long and short, in a ratio of 3:2. Brăiloiu (1984) and his Bulgarian coeval Stoyan Dzhudzhev (1931, 1980) sought to systematize the possible combinations of short and long beats and identify their properties, a project that a handful of authors have continued more recently (e.g., Arom, 2004; Cler, 1994; London, 2012). In music from southeastern Europe, common *aksak* sequences include short-long, short-short-long, long-short-short, short-short-short-long, and short-short-long-short-short'' (Goldberg, 2015, pp.305*).* Sakin and Öztürk (2016, pp.834) explained more in detail that **''**in addition to having different time signatures, these meters include different patterns for the same time signature; in fact the patterns, which contain different rhythmic structures'', while enriching the rhythm at the same time makes it more difficult to perform or learn by the students. For example, the 5/8 aksak meter has 2 different forms (2+3, 2+3), the 7/8 aksak meter has 3 different forms (2+2+3, 2+3+2, 2+3+2+2 and 3+2+2) and 9/8 aksak meter has 4 different forms (2+2+2+3, 2+2+3+2, 2+3+2+2 and 3+2+2+2). As mentioned before aksak meters have different rhythmic specialties in time signatures and rhythmic structures.

Statement of the Problem

Since aksak meters include different rhythmic patterns, in our study we choose specifically only the simplest rhythmic pattern examples 5/8= (2+3), 7/8= (2+2+3) and 9/8= (2+2+2+3). These meters are not formed equally and teaching these meters to the students usually takes a long time and learning these meters requires a dedicated effort. At this point, as it is stressed in many studies mathematics as a good assistant in teaching by explaining the concepts of rhythm and measure (Nemirovsky, et al., 1998; Bautista and Roth, 2012**),** we used mathematics especially geometric symbols in order to teach aksak meters to 6^{th} grade students. We thought that using geometric shapes by matching them to musical meters could be helpful in music lessons. By doing that our expectation was that students could recognize, distinguish and understand aksak rhythmic structures and meters better.

We choose teaching Aksak Meters 5/8, 7/8 and 9/8 which are specific to Anatolian music culture and are not equally grouped which makes them a challenge for the teachers and the students. Through experience, we realize that it can be a very difficult task to explain aksak meters and to teach students to identify those meters in a theoretically manner. This is especially relevant in younger students. The main idea in this study is to research if visualizing aksak meters, which are an intangible concept, in forms of geometrical shapes can make them tangible and understandable for 6th grade students.

The problem sentence for which a solution was sought in this study was formed on the basis of all these thoughts. In this context, the main problem of the research is to reveal whether 5/8, 7/8, and 9/8 aksak meters can be taught effectively by matching them with geometric shapes. In other words, the contribution of this study to the field of music education is to reveal whether the use of geometric shapes in teaching aksak meters benefits students learning outcomes.

Sub-problems formed under this main problem can be listed as follows:
1. Can students ability to distinguish simple meters from aksak meters be improved by teaching them those meter through geometric shapes?
2. Can students learn aksak meters better by matching them to geometric shapes?

2. Method

2.1 Research Model

The research model of this study is the pre-test - post-test control group model. "In this model, there are two groups formed by unbiased assignment. One of them is experimental; the other one is used as the control group. Measurements are made before and after the experiment under equal conditions in both groups"(Karasar, 2016, p. 132).

2.2 Participants

There were 55 participants in the Experimental and 65 participants in the Control Group.

Table 1: Gender and School Types

Gender	**N**	**%**
Female	68	56,7
Male	52	43,3
School Types		
Government: Gülen Muharrem Pakoğlu/ Ankara	65	54,2
Private: Büyük Kolej/ Ankara	55	45,8

Table1. Shows that female participants were dominant with 56.7% while male participants were 43.3%. Participants were from one government and one private school, where 54.2% of them were from government school and the 45.8% were from private school.

Table 2: Weekly Schedules for Experimental Group

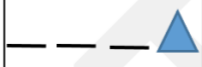
Experimental Group **Private School (Büyük Kolej)**							
1st week	**2nd week**	**3rd week**	**4th week**	**5th week**	**6th week**	**7th week**	**8th week**
PRE-TEST	Introducing Geometric Shapes as Meters 1, 2 2/4= —— 3/4= **1,2,3**  4/4=**1,2,3,4**  Practicing with Geometric Shapes drawn on the floor Dancing on the drawn shapes with sample songs Practicing Body Percussion	Teaching Aksak meter Time Signature Explaining aksak meters with Geometric Shapes 2 + 3  Practicing on the floor with 5/8 meters with music Practicing 5/8 meter w/ the geometrical work sheets	Explaining 7/8 meters with Geometric Shapes 2+ 2+ 3  Practicing on the floor with 7/8 meters with music Practicing 7/8 meter with the geometrical work sheets Practicing Body Percussion	Explaining 9/8 meters with Geometric Shapes 2+ 2+ 2+ 3  Practicing on the floor with 9/8 meters with music Practicing 9/8 meter with the geometrical work sheets Practicing Body Percussion	Practicing all meters with Geometric Shapes Practicing all meters on the worksheet	Practicing all meters with Geometric Shapes Practicing all meters on the worksheet	General Repetition of the whole method and future practicing
Teaching Time Signatures Teaching 2/4, 3/and 4/4 meters Practicing with different meter songs							POST-TEST

Table 3: Weekly Schedules for Control Group

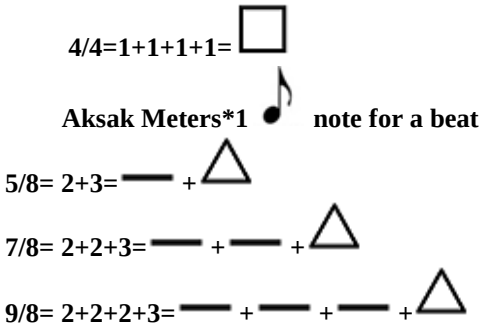
Control Group **Government School (Gülen Muharrem Pakoğlu)**							
1st week	**2nd week**	**3rd week**	**4th week**	**5th week**	**6th week**	**7th week**	**8th week**
PRE-TEST	Teaching meters with Classical Method Listening to sample songs	Teaching Aksak meter Time Signature Explaining aksak meters with Classical Method Explaining 5/8 meter with Classical Method Practicing 5/8 meter with work sheets	Explaining 7/8 meter with Classical Method Practicing 7/8 meter with work sheets	Explaining 9/8 meter with Classical Method Practicing 9/8 meter with work sheets	Practicing all meters Practicing all meters on the worksheet	Practicing all meters Practicing all meters on the worksheet	General Repetition of all practiced meters and future practising
Teaching Time Signature Teaching 2/4 3/4 4/4 meters							**POST-TEST**

Data Collection

Questions specific to the study were prepared and applied as "pre-test" before various teaching activities for teaching geometric shapes and aksak meters, and as "post-test" after these activities. The rhythm heard in the questions, for example a rhythm of two quarters, must match the shape of the rhythm (strait line). Similarly matching strait line + triangle is required for 5/8 meter rhythm. Only one shape (circle) has been added for checking purposes; a question for recognizing a dimension that actually matches this shape was not asked. A total of 14 rhythmic questions specific to the study were prepared by taking expert opinions by the researchers. The reliability of the rhythmic test was measured with Kuder-Richardson Formula 20, or KR-20. KR-20 is a measure reliability for a test with binary variables (i.e. answers that are right or wrong). The Kuder- Richardson-20 reliability coefficient (r) for this study was found to be 0.89. This shows that the prepared questions are highly reliable. The participants were asked to mark if the rhythmic patterns they hear during the test were representing “similar, different or identical” musical meters. The answers were distributed in two groups which are ’’True’’ or ’’False’’.

First personal information was taken. The pre and post tests given to the both groups consisted two parts.
Part 1 was made in order to determine of similar different or repeating musical meters. Every question (RP1, RP2,) included two rhythmic patterns. It included 8 questions in total.
Part 2 of the test aimed to evaluate the students’ degree of matching the rhythm patterns including simple and aksak meters with simple geometrical shapes that 6th grade students can easily perceive and understand (Appendix 1). It included 8 questions in total.

Simple Meters* 1 **note for a beat**
2/4=1+1=
3/4=1+1+1= 



FINDINGS AND INTERPRETATION

Table 4: Distinguishng Simple Measures from Aksak Measures Part 1 Question 1

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	6	2	8	0,180
		Wrong	7	50	57	
	Total		13	52	65	
Experimental Group	Pre-test	Right	27	1	28	**0,000***
		Wrong	26	1	27	
	Total		53	2	55	

This question included (Simple2/4 and Simple 4/4) two simple meters, so the right answer was 'Similar Meters.' According to the statistical analysis there is not statistically significant relation in scores of the pre-test and post-test of the control group ($p>0,05$). While experimental group pre-test and post test scores are statistically significant ($p<0,05$).

According to these findings students that gave the right answer in experimental group increased in the post test. These findings show that experimental group was able to recognize similar simple meters better after their training.

Table 5: Distinguishing Simple Measures from Aksak Measures Part 1 Question 2

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	27	1	28	**0,006***
		Wrong	11	26	37	
	Total		38	27	65	
Experimental Group	Pre-test	Right	41	2	43	**0,013***
		Wrong	12	0	12	
	Total		53	2	55	

This question included (Simple2/4- and Aksak5/8) one simple one aksak meter, so the right answer was 'Different Meters.' According to the statistical analysis there is statistically significant relation in scores of the pre-test and post-test of the both groups ($p<0,05$). Accordingly both groups right answers increased in their post test scores.

These findings show that both groups were able to recognize the difference between simple and aksak meters better after their training.

Table 6: Distinguishing Simple Measures from Aksak Measures Part 1 Question3

			Post Test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	22	4	26	**0,004***
		Wrong	18	21	39	
	Total		40	25	65	
Experimental Group	Pre-test	Right	23	4	27	**0,000**
		Wrong	27	1	28	
	Total		50	5	55	

This question included (Aksak7/8- and Aksak 9/8) two aksak meters, so the right answer was 'Similar Meter.'. According to the statistical analysis there was statistically significant relation in scores of the both control and experimental group ($p<0,05$).

According to these findings students that gave the right answer in both groups increased in the post test. These findings show that both groups were able to recognize similar aksak meters better after their training.

Table 7: Distinguishing Simple Measures from Aksak Measures Part 1 Question 4

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	46	3	49	0,508
		Wrong	6	0	6	
	Total		52	3	55	
Experimental Group	Pre-test	Right	20	3	23	**0,021***
		Wrong	13	29	42	
	Total		33	32	65	

This question included (Aksak7/8- and Simple3/4) one aksak and one simple meter, so the right answer was 'Different Meters.' According to the statistical analysis there is no statistically significant relation in scores of the pre-test and post-test of the control group ($p>0,05$). While the statistical analysis show statistically significant relation in scores of the pre-test and post-test of the experimental group ($p<0,05$).

Accordingly experimental group right answers increased in their post test scores. These findings show that experimental group was able to recognize the difference between simple and aksak meters better after their training.

Table 8: Distinguishing Simple Measures from Aksak Measures Part 1 Question 5

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	13	6	19	1,000
		Wrong	7	39	46	
	Total		20	45	65	
Experimental Group	Pre-test	Right	47	1	48	0,070
		Wrong	7	0	7	
	Total		54	1	55	

This question included (Simple4/4- and Simple 4/4) one simple meter which was repeated, so the right answer was 'Identical Meter.'

According to the statistical analysis there is no statistically significant relation in scores of the pre-test and post-test of the both groups (p>0,05).

Table 9: Distinguishing Simple Measures from Aksak Measures Part 1 Question 6

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	19	5	24	1,000
		Wrong	4	37	41	
	Total		23	42	65	
Experimental Group	Pre-test	Right	31	0	31	**0,000***
		Wrong	21	2	23	
	Total		52	2	54	

This question included (Aksak5/8- and Aksak5/8) one aksak which was repeated, so the right answer was 'Identical Meter.' According to the statistical analysis there is no statistically significant relation in scores of the pre-test and post-test of the control group (p>0,05). While there is statistically significant relation in scores of the pre-test and post-test of the experimental group (p<0,05).
Accordingly experimental groups' right answers increased in their post test scores. These findings show that experimental group was able to recognize the repeating aksak meter better after their training.

Table 10: Distinguishing Simple Measures from Aksak Measures Part 1 Question 7

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	7	3	10	0,092
		Wrong	10	45	55	
	Total		17	48	65	
Experimental Group	Pre-test	Right	24	3	27	**0,000***
		Wrong	26	2	28	
	Total		50	5	55	

This question included (Aksak5/8- and Aksak 9/8) two aksak meters, so the right answer was 'Similar Meters.' According to the statistical analysis there was no statistically significant relation in scores of the both control group (p>0,05). While there is statistically significant relation in scores of the pre-test and post-test of the experimental group (p<0,05). Accordingly experimental groups' right answers increased in their post test scores. These findings show that experimental group was able to recognize the aksak meter better after their training.

Table 11: Distinguishing Simple Measures from Aksak Measures Part 1 Question 8

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	43	5	48	1,000
		Wrong	6	1	7	
	Total		49	6	55	
Experimental Group	Pre-test	Right	12	6	18	**0,035***
		Wrong	17	30	47	
	Total		29	36	65	

This question included (Simple 3/4- and Aksak5/8) one simple and one aksak meter, so the right answer was 'Different Meters.' According to the statistical analysis there is no statistically significant relation in scores of the pre-test and post-test of the control group (p>0,05). While the statistical analysis there is statistically

significant relation in scores of the pre-test and post-test of the experimental group (p<0,05). Accordingly experimental groups' right answers increased in their post test scores. These findings show that experimental group was able to recognize the difference between simple and aksak meters better after their training.

Table 12: Matching Geometrical Shapes with Musical Meters Part 2 Question1

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	6	0	6	0,500
		Wrong	2	57	59	
	Total		8	57	65	
Experimental Group	Pre-test	Right	4	2	6	**0,000***
		Wrong	48	0	48	
	Total		52	2	54	

In relation to the First Geometrical Shape students were expected to *match straight line with simple 2/4 meter*. According to the statistical analysis there is no statistically significant relation in scores of the pre-test and post-test of the control group (p>0,05). While the statistical analysis there is statistically significant relation in scores of the pre-test and post-test of the experimental group (p<0,05). Accordingly the training that experimental group received was more successful for matching 2/4 meter with straight line shape than the traditional training of the control group.

Table 13: Matching Geometrical Shapes with Musical Meters Part 2 Question 2

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	4	1	5	1,000
		Wrong	0	60	60	
	Total		4	61	65	
Experimental Group	Pre-test	Right	5	0	5	**0,000***
		Wrong	38	3	41	
	Total		43	3	46	

In relation to the Fifth Geometrical Shape students were expected to *match (straight line+straight line+straight line +triangle) with aksak 9/8 meter*. According to the statistical analysis there is no statistically significant relation in scores of the pre-test and post-test of the control group (p>0,05). According to the statistical analysis there is statistically significant relation in scores of the pre-test and post-test of the experimental group (p<0,05). Accordingly the training that experimental group received was more successful than the traditional training of the control group which improved their success in matching (straight line+straight line+straight line +triangle) with aksak 9/8 meter.

Table 14: Matching Geometrical Shapes with Musical Meters Part 2 Question 3

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	8	0	8	0,063
		Wrong	5	52	57	
	Total		13	52	65	
Experimental Group	Pre-test	Right	6	1	7	**0,000***
		Wrong	42	4	46	
	Total		48	5	53	

In relation to the Third Geometrical Shape students were expected to *match (straight line+triangle) with aksak 5/8 meter*. According to the statistical analysis there is no statistically significant relation in scores of the pre-test and post-test of the control group (p>0,05). While the statistical analysis there is statistically significant relation in scores of the pre-test and post-test of the experimental group (p<0,05).

Accordingly the training that experimental group recieved was more successful than the traditional training of the control group.

Table 15: Matching Geometrical Shapes with Musical Meters Part 2 Question 4

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	7	0	7	**0,031***
		Wrong	6	52	58	
	Total		13	52	65	
Experimental Group	Pre-test	Right	6	0	6	**0,000**
		Wrong	39	3	42	
	Total		45	3	48	

In relation to the Fourth Geometrical Shape students were expected to *match (straight line+straight line+triangle) with aksak 7/8 meter*. According to the statistical analysis there is statistically significant relation in scores of the pre-test and post-test of the both groups (p<0,05).

Accordingly the training that both groups received improved their success in matching straight line+straight line+triangle with aksak 7/8 meter.

Table 16: Matching Geometrical Shapes with Musical Meters Part 2 Question 5

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	9	1	10	1,000
		Wrong	2	53	55	
	Total		11	54	65	
Experimental Group	Pre-test	Right	10	1	11	**0,000***
		Wrong	36	2	38	
	Total		46	3	49	

In relation to the Second Geometrical Shape students were expected to *match triangle with simple 3/4 meter*. According to the statistical analysis there is no statistically significant relation in scores of the pre-test and post-test of the control group (p>0,05). While the statistical analysis there is statistically significant relation in scores of the pre-test and post-test of the experimental group (p<0,05).

Accordingly the training that experimental group received was more successful for matching 3/4 meter with triangle shape than the traditional training of the control group.

Table 17: Matching Geometrical Shapes with Musical Meters Part 2 Question 6

			Post-test		Total	P
			Right	Wrong		
Control Group	Pre-test	Right	11	1	12	0,625
		Wrong	3	50	53	
	Total		14	51	65	
Experimental Group	Pre-test	Right	9	0	9	**0,000***
		Wrong	40	4	44	
	Total		49	4	53	

In relation to the Sixth Geometrical Shape students were expected to *match square shape with simple 4/4 meter*. According to the statistical analysis there is no statistically significant relation in scores of the pre-test and post-test of the control group ($p>0,05$). While there is statistically significant relation in scores of the pre-test and post-test of the experimental group ($p<0,05$).

Accordingly the training that experimental group received was more successful for matching 4/4 meter with square shape than the traditional training of the control group.

CONCLUSION & SUGGESTIONS

1. The Ability of Students to Distinguish Aksak Measures from Simple Measures:

According to the data obtained, as a result of the educational practices students participated in the experimental group developed their ability to distinguish 5/8, 7/8, 9/8 aksak meters from, 2/4, 3/4, 4/4 simple meters in great proportions. In order to determine the level of attaining this skill, in the pre-test post-test responses of the rhythm questions experimental group showed statistically better results than the control group to more than half of the asked questions. In total of eight questions that were asked they showed statistically significant increase in their results in seven of the questions.

These results show that training applications that are made by matching the aksak meters to geometric shapes, greatly improved the ability to distinguish aksak meters from simple meters for experimental group students. In other words the targeted behavior change was formed, so these results demonstrate that the method used in this study, is a significantly effective teaching method for 6^{th} grade students. Students learning outcomes in the experimental group showed better results.

2. Students Abilities to Match Aksak Meters with Geometrical Shapes:

According to the measurements for matching aksak meters with geometrical shapes, students in the experimental Group had significantly higher scores than the participants in the control Group. In other words students learning outcomes in the experimental group showed better results than the students who attended in the control group. This result is based on the fact that training program applied to experimental group students helped them to improve their skills for recognizing aksak meters, better than the students participating in control group, this demonstrates that teaching through matching geometrical shapes with musical meters, was a significantly effective teaching method for teaching Aksak meters to 6^{th} grade students. This study reveals the success of using Geometrical Shapes in teaching aksak meters to the 6th grade students compared to the traditional teaching methods.

SUGGESTIONS

This study presents a unique method of teaching musical meters through mathematical analogies and offers an interesting perspective of teaching and learning aksak meters.

We suggest that a further study subject could be observing if the students who have never experienced aksak meters before in his/her life can identify aksak meters with Geometrical Shapes and compare the findings to this study results.

Concepts which are hard for students to understand in music lessons could be taught with the help of activities related with mathematics.

The Geometrical Shapes can be used in the schools and be included text books to help teach aksak meters.
Other research subject could be teaching complex meters such as 10/8 with the help of different Geometrical Shapes.[i]

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[i] One part of this study was presented at 32ndWorld Conference of International Society for Music Education, 24 - 29 July 2016, Royal Conservatoire of Scotland, Glasgow, United Kingdom

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Appendix 1

Personal Information
1-Gender: ( ) G ( ) B
2-School Name: …….
3-Grade: …….....

Part 1

In this section, there are 8 rhythmic groups consisting of two separate rhythm phrases.
The two rhythms in each group are going to be tapped consecutively with short breaks two times.
Identical Meter = **Both of the rhythmic phrases are in the exactly same meter such as: 4/4 =4/4**
Different Meters = **The rhythmic phrases are from different meter type such as: Simple meter + Aksak meter or Aksak meter +Simple meter**
Similar Meters = **Both of the rhythmic phrases are from the same type: Simple meter + Simple meter or Aksak meter + Aksak meter**

Please mark one of the options

1. a) Identical Meter b) Different Meters c) Similar Meters

2. a) Identical Meter b) Different Meters c) Similar Meters

3. a) Identical Meter b) Different Meters c) Similar Meters

4. a) Identical Meter b) Different Meters c) Similar Meters

5. a) Identical Meter b) Different Meters c) Similar Meters

6. a) Identical Meter b) Different Meters c) Similar Meters

7. a) Identical Meter b) Different Meters c) Similar Meters

8. a) Identical Meter b) Different Meters c) Similar Meters

Part 2

In this section, you are going to hear are 6 rhythmic patterns.
The rhythmic pattern for each question is going to be tapped twice. Please match the rhythmic patterns with the geometrical shapes given below.

Please mark only one of the options for each question.

Geometric Shape	**Question 1 RP1**	**Question 2 RP2**	**Question 3 RP3**	**Question 4 RP4**	**Question 5 RP5**	**Question 6 RP6**
	Şen Çalgıcılar (2/4)					
					Halay Saip Egüz (3/4)	

						Ilgaz Anadolu'nun (4/4)
			Sevgi Çiçekleri (5/8)			
				Çay Elinden Öteye (7/8)		
		Kızılcıklar Oldu mu (9/8)				
						

Note: The rhythmic patterns for the test were chosen from Turkish songs. They are shown here just for information. Students received that part of the test empty.