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Influence of the Constructivist Learning Approach on Students' Levels of Learning Trigonometry and on Their Attitudes Towards Mathematics

Yapılandırmacı Öğrenme Yaklaşımının Öğrencilerin Trigonometriyi Öğrenme Düzeylerine ve Matematiğe Yönelik Tutumlarına Etkisi

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ABSTRACT: In this experimental study, the influence of the constructivist learning approach on students' levels of learning trigonometry and on their attitudes towards mathematics was examined in comparison with the traditional methods of instruction. The constructivist learning approach was the independent variable, while mathematics achievement, the lessons of trigonometry and the attitudes towards mathematics constituted the dependent variables. The study was designed as the pretest-posttest control group model. In order to collect the research data in the experimental study, the achievement test, the math attitude test and the material evaluation form developed to measure the influence of the instructional materials on learning were applied. An interview form developed to evaluate the students' views about the application was applied. In order to measure the students' attitudes towards mathematics, an attitude math scale was developed by the researcher. The internal consistency of the scale was calculated as 0, 9174. For the evaluation of the instructional materials, the instructional material evaluation form developed by Ardahan (2003) was applied. Based on the results obtained in the present study, it was concluded that in teaching mathematics, the constructivist learning approach helped maintain more permanent learning than the traditional method of instruction and helped develop positive attitudes towards mathematics.

Key Words: Trigonometry Teaching, Constructivist Learning, Math Attitude Scale

ÖZET: Bu deneysel çalışmada, yapılandırmacı öğrenme yaklaşımının öğrencilerin trigonometriyi öğrenme düzeylerine ve matematiğe yönelik tutumlarına etkileri geleneksel öğretim yöntemleri karşılaştırmalı olarak incelenmiştir. Yapılandırmacı öğrenme yaklaşımı bağımsız değişkeni oluştururken, matematik başarısı trigonometri ünitesi ve matematik dersine ilişkin tutum ise bağımlı değişkenleri oluşturmaktadır. Araştırmada, ön test-son test kontrol gruplu deneme modelinde tasarlanmıştır. Deneysel çalışmada, veri toplamak amacı ile başarı testi, matematiğe yönelik tutum testi ve geliştirilen öğretim materyallerinin öğrenmeye etkisini ölçmek amacı ile materyal değerlendirme formu uygulandı. Öğrencilerin uygulamaya yönelik görüşleri geliştirilen görüşme formu ile değerlendirildi. Öğrencilerin matematiğe yönelik tutumlarını ölçmek amacı ile araştırmacı tarafından matematik tutum ölçeği geliştirildi. Ölçeğin iç tutarlılık kat sayısı 0,9174 olarak hesaplanmıştır. Öğrencilerin geliştirilen öğretim materyallerini değerlendirilmesi amacı ile Ardahan (2003) tarafından geliştirilen öğretim materyali değerlendirme formu uygulandı. Bu çalışmada elde edilen sonuçlara dayalı olarak, matematik öğretiminde, yapılandırmacı öğrenme yaklaşımının geleneksel öğretim yaklaşımından daha kalıcı öğrenme sağladığı ve matematik dersine karşı olumlu tutum geliştirilmesine yardımcı olduğu sonucuna varılmıştır.

Anahtar Kelimeler: Trigonometri Öğretimi, Yapısalcı Yaklaşım, Matematik Tutum Ölçeği

1. INTRODUCTION

In this global world, technological changes influence everything from people's way of working to their communication with each other as well as to the way they spend their free time. This change makes it compulsory to restructure education in line with pedagogy, literacy, applications and goals (Kellner, 2002). Developments in the fields of science and technology have influence both on the structures of societies and on educational systems. Today, it is important to train individuals who produce information rather than those who merely use it. In this respect, instructors of science and mathematics have great responsibilities (Akkoyunlu, 1996). When the education system in our country is examined, one mostly encounters with a traditional structure made up of an introvert class environment, a teacher and a group of students, the course book, desks and the white board (Başaran, 1993). Instruction carried out via the

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constructivist learning approach increases a student's level of achievement in mathematics more than traditional method of instruction does (Erdoğan and Sağan, 2002). It is seen that in teaching geometrical figures and concepts, computer- and material-supported instruction is effective (Alabay and Ünüsan, 2007). It is claimed that use of materials will not only encourage students to think but also help execute enjoyable lessons (Toluk and Olkun, 2007). In short, in teaching mathematics, the material is quite a strong instructional tool that allows transition from the thought of "solving the problem" to the thought of "revealing the problem" (Abromocivh, 1997). The results of an experimental study carried out with the constructivist learning approach revealed that the use of the constructivist learning approach would not only increase the quality of education but also train more equipped individuals (Akgün, 2006). Based on the comparison of the Turkish and British education systems, it was concluded that the subject of trigonometry in mathematics teaching was ignored. Although trigonometry-related verbal questions have an important place in England while being ignored in Turkey, students in both countries favored a similar approach in solving such questions (Delice, 2004). The use work-sheets in the course of mathematics leads to more successful results than the use of traditional methods of teaching does (Özahiska, Öcal, 2004). The processes influencing learning are stated mainly to be recognition, perception and interest, information coding and storing, remembering and organizing. Visual materials play a role in all these processes (Erkan, 2006). One of the theories related to how to code and store information in the long-term memories is the theory of dual coding (Paivio, 1971). According to this theory, information is stored in the long-term memory both verbally and visually. Thus, it is more likely to remember the information presented verbally and visually. In traditional teaching methods, generally, the process of solving a problem is not taken into consideration at all. However, in the material-based teaching approach, the way to handle the problem and the strategies applied to solve the problem are more important (Dede 2003 cited in Neyland, 1994). Gelen and Hoover (1996), in their study called "Expanding Opportunities for Ffa Chapter Recognition", stated that children who feel themselves comfortable with spatial relationships and who know geometrical concepts well are prepared for learning advanced mathematical subjects and that knowledge about geometrical relationships develop children's spatial thinking skills. The sine and cosine values of angles can be calculated on the millimeter paper and transformed into trigonometric scale (Altun, 2005). In the experimental study carried out to understand the reasons why subjects considered as difficult by students are perceived so, two important reasons for the difficulty stand out: Lack of motivation and conceptual abstractness (Durmuş, 2004). They claim that students structure their knowledge and social lives directly (Shirin, 2002). The constructivist learning approach provides students with the opportunity to learn new information and to put their knowledge into practice (Rauff and James, 1994). The constructivist learning approach helps students internalize the information and transform it into new knowledge (Halloway, 1999). This approach summarizes the teaching and learning process with the concept map (Eisenkraft, 2003; Stone, 2004; Edgar Dale, 1969 cited in Heinich, 1993). It could be stated that traditional instruction does not have a structure and process based on the differences between the students' learning abilities, their level of knowledge, their academic sub-structures and their goals (Brusilovsky, Eklund and Schwarz, 1998). Salih Zeki, in his work called "Asar-ı Bakiye", talks about the studies of oriental scientists in the field of mathematics and sheds light on a number of calculation- and trigonometry-related subjects that can only be handled in long-term studies (İnönü, 2004). One of the most important difficulties experienced in teaching basic concepts in trigonometry is that students tend to memorize trigonometric concepts rather than envisaging these concepts. This is mostly due to the exam system executed (İnan, 2006).

2. PURPOSE

The purpose of the present study was to investigate whether there were the statistically significant differences between the achievements and attitudes of experimental and control groups from two schools – one public school and the other private school, and from each school one experimental group and one control group - as a result of teaching the basic concepts of trigonometry – the introductory lesson unit of trigonometry – via traditional method of instruction in the control group and via the constructivist learning approach in the experimental group. In line with this, the influence of traditional teaching on students' achievement was examined and compared with the influence of constructive learning on students' achievement and attitudes. As the sub-goals, the study aimed at measuring and evaluating the influence of the instructional materials – used in the study - on the teaching environment with the use of the material evaluation form developed by Ardahan (2000) and also aimed at measuring and evaluating the teachers and students' views about the experimental study with the use of the interview form developed by the researcher.

3. METHOD

The present study, in which the effects of two different teaching methods on students' achievement and attitudes were compared, employed the pretest-posttest control group model. The sample: The study was carried out in a period of two months with 51 2nd grade students (25students in the experimental group and 26 students in the control group) attending a private high school in the city of Diyarbakır and with 49 2nd grade students (24 students in the experimental group and 25 students in the control group) attending a public high school in the same city. In the analysis of quantitative data descriptive research method and mean, Independent/dependent Groups t-Test were used.

3.1 Data Collection Tools

As the data collection tool, an achievement test including 25 multiple-choice questions, a Likert-type 5-point mathematics attitude scale including 30 statements and an interview form were used. While preparing the questions found in the achievement test, first, the table of specifications regarding the lesson unit of trigonometry to be taught was prepared. According to this table of specifications, the analysis of the lesson unit was carried out as appropriate to such steps of the cognitive field as knowledge, comprehension and application. Depending on the relationship between the subjects and the goal in question, a preliminary test including 50 multiple-choice items was prepared. This preliminary test prepared was examined by teachers or mathematics from two different high schools as well as by a faculty member from the Department of Turkish Language Education due to intensive language use. As a result of these examinations, the necessary corrections were made, and the test was ready for experiment. Finally, the test was distributed to mathematics teachers from high school in the central town of Diyarbakir to investigate its appropriateness to the students' levels. Based on the suggestions put forward by the teachers, the test was revised, and the number of the test items was decreased to 30. Following this, the test revised was applied to 57 students attending the Central High School in Diyarbakir as an independent group. Because the results of the test given revealed that four students did not respond to the test, these four students were excluded from the study. As a result of the item analysis, the items with the distinctiveness indices lower than 0,20 were excluded from the test, and the final version of the test, called achievement test, included 25 items. Mathematics Attitude Scale: In the first place, an item pool was set up by the researcher. For this purpose, a group of students (50) were asked to write down their own feelings and thoughts about mathematics. These written texts were examined, and the statements labeled as attitudes were arranged as positive or negative. In order to decide whether the attitude statements were appropriate in terms of such aspects as language, expression and instruction, expert view was necessary. As a result, the

outline scale was prepared including a total of 48 items, 15 of which were negative. After the outline scale was applied to students (157) in an independent high school, the data obtained were transferred into a computer. The scale score of each subject was calculated considering whether the scale items were positive or negative. For the scoring of the items, the positive items were scored from 5 to 1, while the negative items were scored from 1 to 5. In order to obtain a reliable scale, the item total score correlations of the outline scale were examined. 16 items with the item-total correlation lower than 0,3 were excluded from the scale. The item numbers with the item-total correlation lower than 0,3 were as follows: 8, 9, 16, 20, 22, 24, 25, 27, 28, 29, 33, 44, 45, 46, 47. Following this, factor analysis was applied to the remaining 32 items. In factor analysis, the load values of the first factors of the items were examined. As a result, it was found out that the 21st and 43rd items with the factor load lower than 0,400 spoils the construct validity. These items were excluded from the outline scale. After factor analysis was applied again to the remaining 30 items, it was found out that the first factor loads of all the items were higher than 0,400. It was also revealed that the factor loads ranged between 0,416 and 0,778. The Cronbach alpha internal consistency of the scale was calculated as 0,9174. Depending on these findings, the 30-item Mathematics Attitude Scale developed could be said to be sufficiently valid and reliable. Interview Form was developed to determine and examine the students and teachers' views about the constructivist learning application. Before the interview form was prepared, which type of tool would be used to determine the students' views about the application was discussed with the class teachers. As a result of these discussions, the researcher, together with the teachers, decided to prepare an interview form including open-ended questions. The outline interview form including ten open-ended questions was prepared. This outline interview form was presented to high school literature teachers for their views about its language and expression. The outline interview form prepared as appropriate to the information in related literature was applied to 2nd grade students (30) attending School A in the central town of Diyarbakir. The questions which were not responded to or those which were determined to be misunderstood were excluded from the outline interview form and applied again to the 2nd students (20) attending School A. Following the evaluation of the results obtained from the teachers and the students, the interview form was finalized. The data regarding the influence of trigonometry course materials developed by the researcher on the experimental study were obtained via the material evaluation form developed by Ardahan (2000). The students who did not respond to all of the attitude and achievement scales due to absenteeism during the application were excluded from the sample during the analysis of the data. The present study included the 'remember me?' test repeated at the end of the sixth week following the end of the application as well as the four-week application. Before the application, both the mathematics attitude scale and the achievement test prepared for the trigonometry lesson unit were applied as pretest to the experimental and control groups determined in both high schools. At the end of the application, the achievement and attitude tests previously applied as pretest to the groups in both schools were applied as posttest. In order to measure permanence in achievement, the achievement test prepared was applied again to the same groups in both schools after a period of 6 weeks following the end of the application. After the data obtained were arranged, the techniques of descriptive statistics, paired t-test and variance analysis were used to analyze the data. The quantitative data were analyzed with the SPSS package program by benefitting from means and t-test for dependent and independent variables. The level of statistical significance was taken as 0.05. The influence of the instructional materials developed as the sub-goals on the teaching environment was measured with the material evaluation form. The data obtained were transferred into tables, and the related graphics were prepared with the use of Excel software. Following this, these tables and graphics were interpreted. In order to take the students and teachers' views about the experimental study following the application, interviews were held. The results obtained were evaluated.

3.2 Findings and İnterpretations

In the study, the attitude scale and achievement tests developed by the researcher regarding the course of mathematics were applied as pretest/posttest and as 'Remember Me?' test. The findings obtained were evaluated with respect to the schools, experimental and control groups and gender.

Analysis of the Attitude Pretest Total Scores and Achievement Pretest Total Scores of the Experimental and Control Group Students Attending School A and School B

Table 1: Independent Groups t-Test Results of the Pretest Scores of the Experimental and Control Groups

Groups		N	X	ss	sd	T	P
Attitude Pretest Total	Experimental	50	3,28	0,42	49	0,82	0,41
	Control	51	3,19	0,58	50		0,41
Achievement Pretest Total	Experiment	50	10,56	3,98	49	0,86	0,93
	Control	51	10,49	4,21	50		0,93

When Table 1 was examined, it was seen that the groups had similar mean scores and that there was no significant difference between the attitude pretest scores and the achievement pretest scores (P>0, 05). Depending on these results, it could be stated that the students' overall achievement levels and their attitudes were similar.

Analysis of the Attitude Pretest/Posttest Total Scores and Achievement Pretest/Posttest Total Scores of the Experimental and Control Group Students Attending School A and School B

Table 2 Dependent Groups t-Test Results of the Pretest and Posttest Scores of the Experimental and Control Groups

	Group	N	X	Ss	Sd	t	P
Experimental Group	Attitude Pretest Total	50	3,28	0,42	49	-9,71	0,00
	Attitude Posttest Total	50	4,08	-0,41			
	Achievement Pretest Total	50	10,56	3,98	49	-18,25	0,00
	Achievement Posttest Total	50	21,96	4,16			
Control Group	Attitude Pretest Total	51	3,19	0,58	50	-1,59	0,11
	Attitude Posttest Total	51	3,37	0,53			
	Achievement Pretest Total	51	10,49	4,21	50	-6,53	0,00
	Achievement Posttest Total	51	15,51	3,84			

When Table 2 was examined, it was seen that there were significant differences between the attitude pretest and attitude posttest scores and between the achievement pretest and achievement posttest scores in the experimental group (P<0,05). In the control group, no significant difference was found between the attitude pretest and attitude posttest scores; however, the results revealed a significant difference between the achievement pretest and achievement posttest scores in the control group. Based on these results, it could be stated that the experimental group students' attitudes changed positively; on the other hand, it was revealed that there was no change in the attitudes of those in the control group.

Analysis of the Attitude Posttest Total Scores and Achievement Posttest Total Scores of the Experimental and Control Group Students Attending School A and School B

Table 3 Independent Groups t-Test Results of the Posttest Scores of the Experimental and Control Groups

Group		N	X	ss	sd	t	P
Attitude Posttest	Experiment	50	4,08	0,41	99	7,44	0,00
	Control	51	3,37	0,53			
Achievement Posttest	Experiment	50	21,96	4,16	99	8,09	0,00
	Control	51	15,51	3,84			

When Table 3 was examined, it was seen that there was a significant difference between the posttest scores in favor of the experimental group (P<0,05).

Analysis of the Achievement Posttest/Achievement 'Remember Me' Total Scores of the Experimental and Control Group Students Attending School A and School B

Table 4 Independent Groups t-Test Results of the Posttests and 'Remember Me' Total Scores in the Experimental and Control Groups

	Group	N	X	ss	sd	t	P
Experimental Group	Achievement Posttest	50	21,96	4,16	49	0,64	0,52
	Achievement 'Remember Me'	50	21,50	4,06			
Control Group	Achievement Posttest	51	15,51	3,84	50	0,49	0,62
	Achievement 'Remember Me'	51	15,20	3,54			

When Table 4 was examined, it was seen that there was no significant difference between the posttests and 'Remember Me' tests in the experimental and control groups with respect to achievement.

Analysis of Attitude Posttest and Achievement Posttest Scores of the Experimental and Control Group Students Attending School A and School B with Respect to Gender

Table 5 Independent Groups t-Test Results of the Posttests in the Experimental and Control Groups with Respect to Gender

Group Gender		N	X	ss	sd	t	p
Experimental Group	Attitude Posttest 1(Male)	29	4,02	0,46	48	.1,24	0,21
	Attitude Posttest 2(Female)	21	4,17	0,33			
	Achievement Posttest 1(Male)	29	21,24	5,11	48	1,45	0,15
	Achievement Posttest 2(Female)	21	22,95	2,12			
Control Group	Attitude Posttest 1(Male)	34	3,49	0,44	49	2,42	0,19
	Attitude Posttest 2(Female)	17	3,12	0,61			
	Achievement Posttest 1(Male)	34	15,94	3,70	49	1,13	0,26
	Achievement Posttest 2(Female)	17	14,65	4,07			

When Table 5 was examined, it was seen that there was no significant difference between the posttests of the experimental and control groups in terms of gender (P>0,05). According to these results, it could be stated that students in both groups held similar thoughts with respect to gender.

Analysis of Attitude Pretest-Posttest and Achievement Pretest-Posttest Scores of the Experimental and Control Group Students Attending School A and School B with Respect to Gender

Table 6 Dependent Groups t-Test Results of the Pretests and Posttests in the Experimental and Control Groups with Respect to Gender

Group	Gen		N	X	ss	sd	t	P
Experimental Group	Male	Attitude Pretest	29	3,24	0,31	28	-7,34	0,00
		Attitude Posttest	29	4,02	0,46			
		Achievement Pretest	29	10,14	3,85	28	-11,97	0,00
		Achievement Posttest	29	21,24	5,11			
	Female	Attitude Pretest	21	3,32	0,54	20	-6,23	0,00
		Attitude Posttest	21	4,17	0,33			
		Achievement Posttest	21	11.14	4.17	20	-15.29	
		Achievement Posttest	21	22.95	2.01			
Control Group	Male	Attitude Pretest	34	3,21	0,61	33	-2,29	0,07
		Attitude Posttest	34	3,49	0,44			
		Achievement Pretest	34	10,59	4,17	33	-5,27	0,00
		Achievement Posttest	34	15,94	3,70			
	Female	Attitude Pretest	17	3,17	0,53	16	0,22	0,82
		Attitude Posttest	17	3,12	0,61			
		Achievement Pretest	17	10,29	4,42	16	-3,90	0,00
		Achievement Posttest	17	14,65	4,07			

When Table 6 was examined, it was seen that with respect to gender, between the pretests and posttests of the experimental and control groups, there was no significant difference between the female and male students' views in the experimental group (P<0,05) and that there was a significant difference regarding the achievement scores yet no significant difference regarding the attitude scores of the female students or regarding the male students in the control group (P>0,05).

Analysis of Achievement Posttest/'Remember Me' Scores of the Experimental Group Students Attending School A and School B with Respect to Gender

Table 7 Dependent Groups t-Test Results of the Posttest and 'Remember Me' Test in the Experimental Groups with Respect to Gender

Group	Gender		N	X	ss	sd	t	p
Experimental Group	Male	Achievement Posttest	29	21,24	5,1	28	0,2	0,8
		Achievement 'Remember Me'	29	21,45	3,9			
	Female	Achievement Posttest	21	22,95	2,0	20	0,8	0,4

"When Table 7 was examined, it was seen that there was no significant difference between the achievement posttest and achievement 'Remember Me' tests in the experimental groups with respect to gender (P>0,05).

Analysis of the Pretests/Posttests of the Experimental and Control Group Students Attending School A and School B with Respect to the schools

Table 8 Dependent Groups t-Test Results of the Pretests and Posttests of the Experimental and Control Groups with Respect to the schools

School	Group		N	X	ss	sd	t	p
School A	Experimental Group	Attitude Pretest	25	3.18	0.41	24	-6.81	0.00
		Attitude Posttest	25	4.04	0.49			
		Achievement Pretest	25	8.32	3.62	24	-13.03	0.00
		Achievement Posttest	25	21.20	4.74			
	Control Group	Attitude Pretest	25	3.14	0.69	24	-0.83	0.41
		Attitude Posttest	25	3.31	0.69			
		Achievement Pretest	25	9.84	4.37	24	-5.72	0.00
		Achievement Posttest	25	14.88	3.46			
School B	Experimental Group	Attitude Pretest	25	3.37	0.42	24	-6.88	0.00
		Attitude Posttest	25	4.12	0.32			
		Achievement Pretest	25	12.80	2.95	24	-14.95	0.00
		Achievement Posttest	25	22.72	3.42			
	Control Group	Attitude Pretest	26	3.25	0.46	25	-1.80	0.08
		Attitude Posttest	26	3.43	0.31			
		Achievement Pretest	26	11.12	4.04	25	-3.95	0.00
		Achievement Posttest	26	16.12	4.15			

When Table 8 was examined, it was seen that regarding the pretests and posttests of the experimental and control groups with respect to the schools, there were significant differences between the attitude and achievement scores of the experimental group ($P<0.05$) and only in the achievement scores of the control group in School A; in addition, it was also seen that in School B, there was a significant difference between the attitude and achievement scores of the experimental group and only in the achievement scores of the control group.

Analysis of the Independent Groups t-Test Results of the Posttest and 'Remember Me' Test of the Experimental and Control Groups with Respect to the schools was examined, it was seen that there was no significant difference between the achievement posttest and achievement 'Remember Me' Test of the experimental and control groups with respect to the two schools ($P>0.05$).

Analysis of the Dependent Groups t-Test Results of individual comparison of the Pretest and Posttest of the Experimental and Control Groups was examined, it was seen that there was a significant difference between the pretest and posttest scores of the experimental group students attending the two schools ($P<0.05$). In addition, the results also revealed a significant difference regarding the control group students' achievement scores yet no significant difference regarding their attitude scores ($P>0.05$).

Analysis of the Dependent Groups t-Test Results of individual comparison of the Posttest and 'Remember Me' Test of the Experimental and Control Group Students from the Two Schools was examined, it was seen that there was no significant difference between the posttest and 'Remember Me' test of the experimental and control group students from the two schools ($P>0.05$). However, the results also revealed a significant difference regarding only the attitude scores of the students attending the School B in favor of the posttests ($P<0.05$).

3.3 Material Evaluation

Depending on the positive result obtained at the end of the experimental study regarding the influence of the instructional materials developed by the researcher on the students' achievement and on their attitudes towards the lesson, the material evaluation form was used to

determine the students' views. The data collected were interpreted with the help of Excel graphic charts.

Students' Views about the Evaluation of Instructional Materials Overall Views about the Material

Table 9 Overall Views about the Material

EXPLANATION	VALUES		PERCENTAGE		GENERAL PERCENTAGE
	1ST SCHOOL	2ND SCHOOL	1ST SCHOOL	2ND SCHOOL	
GOOD	15	15	62	60	61
IT WOULD BE MUCH BETTER	7	8	29	32	30
AVERAGE	2	2	08	08	08
BAD	-	-	-	-	-
TOTAL	24	25	100	100	100

When Table 9 was examined, it was seen that 61% of the students generally reported positive views about the material and that the views of 0,8 of the students were in middle. In addition, 30% of the students stated that it would be better if the deficiencies in the material were overcome.

3.4 The Students and Teachers' Views About The Constructive Learning Application

In this section, depending on the results of the interview form developed, the students' views about the constructivist learning application – which constituted the sub-goals of the study – and about the experimental application in the schools are discussed. In addition, this section also presents the teachers' views determined in written form following the presentation in which the experimental study was introduced.

Students' Views:

Question 1: What do you think about the material-based trigonometry lesson taught with the constructivist learning approach? The responses given to the open-ended interview question can be summarized as follows: It is quite a concrete method that helps remember what has been learnt. Because it is slow and proof-based, it is reliable. The students' fear of trigonometry and mathematics decreases. They can learn by doing and experiencing.

Question 2: Do you think the constructivist learning approach differs from the traditional method of instruction? The participants' responses to the open-ended question can be summarized as follows: Certainly, a difference exists between the two instructional methods. I found the constructivist learning approach more concrete. The constructivist learning approach is quite good since we learn via figures, yet this is not possible with the traditional method of instruction..

Question 3: Which learning approach (traditional/constructivist) do you think would increase our achievement? The participants' responses to the open-ended question can be summarized as follows:

It should be practical and student-centered. The constructivist education increases achievement. Visual information is easily memorable. To me, the constructivist method is better. The other method makes us stressed. Visual information is memorable.

Question 4: Do you have anything to say about this subject? The participants' responses to the open-ended question can be summarized as follows:

We saw the difference between the two methods in trigonometry. It will be better if the other lesson units are taught in the same way. All my friends can see the difference

The students' views support the results of a study carried out by Altun (2006) and those of another one conducted by Gömleksiz, Bulut and Kan (2005).

TEACHERS' VIEWS

Advantages of the Application: The application was student-centered. It made trigonometry more understandable. It helped learn by doing and made learning more permanent. It helped avoid memorizing in mathematics and teach via more visual activities. It proved that trigonometry is not a frightening subject. Scientifically, the application can be considered as a guide for such studies. It increased productivity. It encouraged similar studies to make other branches of mathematics understandable.

Disadvantages of the Application:

The application required a long time and caused delays in the program.

Suggestions: In order to develop the method more, it should be supported with the computer, and teachers appropriate to such applications should be trained.

4. DISCUSSION AND CONCLUSION

In this section, in the experimental study, the findings obtained from the mathematics attitude scale, the trigonometry achievement tests and from the material evaluation and interview form were comparatively evaluated. Besides these evaluations, the teachers and students' views were also taken into consideration while drawing conclusions. Based on the results obtained in the present study, related suggestions were put forward.

In the two schools where the study was carried out, the experimental and control group students' grades in the course of mathematics in the first academic year and their end-of-year average grades were examined. Depending on these data, before the application, the experimental and control groups from the two schools were evaluated individually and as a whole. As a result, they were found to have similar achievement levels. Prior to the experimental study, the achievement test covering the basic trigonometry subjects and the math attitude scale were applied to the experimental and control groups in the two schools. When the groups were evaluated individually and as a whole, it was seen that the results obtained revealed no significant difference between the pretests of the experimental and control groups ($P>0.05$) (Table 1). Thus it can be stated that the experimental and control groups had similar achievement levels and attitudes before the application. This supports the finding obtained from the mean scores of the experimental and control group students' math grades and end-of-year grades in the first academic term in the two schools.

In the two schools, the constructivist learning approach was applied in the experimental groups, and the traditional method of instruction was applied in the control groups. In order to obtain productive results in the study, the researcher himself taught lessons for four weeks. At the end of these lessons, in order to reveal whether there was a change in the experimental and control group students' math achievement and attitudes towards math, an achievement test and an attitude scale were applied. The results obtained demonstrated that there was a significant difference between the attitudes and achievement levels of the experimental group students in favor of the posttests ($P<0.05$). It could be stated that this situation was influential on the experimental groups of the constructivist learning approach and that there were positive changes in their attitudes towards mathematics. It was also revealed that in the control group, there was a significant difference in the students' achievement but no difference in their attitudes. It was

thought that the traditional method of instruction did not cause any change in the students' attitudes towards mathematics; in other words, the students' attitudes towards mathematics remained the same. In addition, their level of achievement was lower than that of the experimental group As a result of this application, it could be stated that generally, the constructivist learning approach was more influential on students' attitudes towards mathematics and on their learning trigonometry when compared to the traditional method of instruction. This finding is similar to the findings of other studies carried out by Dikkarten and Uyangör (2007) and those of another study conducted by Erdoğan and Sagan (2002). The results presented in Table 2 could be said to be due to the trigonometry lessons taught via the constructivist learning approach. It could also be stated that there are a number of lesson units to be taught via the constructivist learning approach in secondary education and that researchers are expected to carry out new studies.

The posttests examined to reveal the differences between the experimental and control group students' achievement posttests and their post attitudes towards mathematics demonstrated that there was a significant difference in favor of the experimental group students with respect to their attitudes and achievement ($P<0.05$) (Table 3). This finding revealed that at the end of the research process, the experimental group students were positively influenced by the constructivist learning approach in terms of their achievement and attitudes and that although the traditional method of instruction slightly increased the control group students' achievement, the method did not influence these students' attitudes towards mathematics.

One month after the experimental study, in order to determine how permanent the students' levels of achievement and attitude were, the achievement scale was applied again to the same groups. When the experimental and control groups' achievement posttests and 'Remember Me' tests were examined, it was seen that there was no significant difference between the experimental and control groups' achievement levels. Depending on this finding, it could be stated that in the experimental and control groups, the students maintained their levels following the experiment and that the experimental group students were better with respect to the permanence of what they had learnt during the lessons (Table 4). When the posttests of the experimental and control groups were independently compared with respect to gender, it could be stated that no significant difference occurred in terms of achievement and attitude and that the students in the experimental and control groups were similar in terms of their achievement and attitude following the experiment (Table 5). In general, the female students were found to be successful. In addition, this finding also supports that of another study which reported "the achievement level increases in parallel to the education level" (Ubuz, 1999).

When the experimental and control group students' achievement pretests posttests and their math attitude pretests/posttests were compared with respect to gender, it was seen that there was a significant difference in the experimental and control group students' achievement with respect to gender ($P<0.05$) yet no significant difference in their attitudes towards mathematics ($p>0.05$) (Table 6). In the experimental groups, with respect to their achievement and attitudes towards mathematics, the female and male students were influenced positively by the trigonometry lessons taught via the constructivist learning approach; on the other hand, it was found out in the control groups that there was a significant difference between the male and female students' achievement in favor of the posttests and that no significant difference occurred in their attitudes towards mathematics ($p>0.05$). It was seen that the traditional method of instruction applied in the control groups increased the female and male students' achievement but did not cause any change in their attitudes towards mathematics. With respect to gender, it could be stated that the experimental and control group students' achievement was significant in favor of the experimental group and that the constructivist learning approach was more successful than the traditional method of instruction in terms of gender. This finding is similar to the finding of another study reported in related literature (Baki and Özpınar, 2007). When the experimental and

control group students' achievement pretests/posttests and their math attitude pretests/posttests were compared with respect to the schools, it was revealed that there was a significant difference regarding the experimental group students' achievement and math attitude in School A ($P<0.05$). As for the control group students, there was a significant difference regarding their achievement ($P<0.05$) yet no significant difference regarding their attitudes towards mathematics ($P>0.05$). In this respect, it could be stated that in the experimental and control groups in the two schools, the students' achievement increased and that positive changes were revealed only in the experimental group regarding the students' attitudes towards mathematics. This result could be said to result from the constructivist learning approach applied. When the permanence of achievement and related differences were compared by examining the experimental and control group students' achievement posttests/achievement 'Remember Me' tests with respect to the schools, no significant difference were found regarding the experimental and control group students attending School A and School B. Based on this result, it could be stated that the students generally maintained their level of knowledge they acquired (Table 7).

The experimental and control group students' achievement pretests/posttests and math attitude pretests/posttests revealed that with respect to the schools, there was a significant difference regarding School A/School B ($P<0.05$) and that in the control group, there was a significant difference in the achievement pretests/posttests regarding School A/School B ($P<0.05$); on the other hand, it was also found out that no significant difference was found between the attitudes towards mathematics. Depending on this result, it could be stated that whichever method of instruction is applied, achievement increases; however, it could also be stated that the increase in achievement is more in the experimental groups and that the experimental group students were more successful with respect to their attitudes towards mathematics (Table 8). When the experimental and control group students' achievement posttests/'Remember Me' tests were compared separately for the two schools, it was seen that no significant difference occurred regarding the experimental group students' achievement posttests/'Remember Me' tests in School A/School B ($p>0.05$) and that the control group students' achievement decreased. Based on this result, it could be stated that the students failed to maintain their achievement levels and the permanence of their knowledge

When the experimental and control group students' achievement pretests/posttests and their math attitude pretests/posttests were compared separately for the two schools with respect to gender, it was revealed that there was a significant difference for the experimental group students attending High School/School B in favor of their achievement and math attitude posttests. It was also found out that there was a significant difference regarding the control group students' achievement in High School A/School B in favor of the posttests yet no significant difference regarding their attitudes towards mathematics. The fact that male and female students had similar levels of achievement and similar attitudes towards mathematics is consistent with the results presented in Table 5. The comparison of the experimental and control group students' posttests/'Remember Me' tests separately for the two schools revealed that there was no significant difference between the experimental and control groups ($P>0.05$). In this respect, it was seen that in the two schools, the experimental groups demonstrated similar attitudes and achievement, and so did the control groups .This result does not support the common belief that private schools are more successful.

In the experimental study, the instructional material evaluation form applied to examine the influence of the instructional material on the teaching environment revealed that about 90% of the students approved the instructional material as 61% of them reported positive views about the material and 30% of them said it would be better if the deficiencies were corrected. This result showed that the material was user-friendly. This result is similar to the results of a study carried out by Ardahan and Ersoy/Aslan and Ardahan (2003) as well as consistent with those of other studies (Olkun and Altun, 2003; Durmuş and Yaman, 2006; Erkan, 2006; and Kayahan, 2006).

According to the evaluation of the teachers and students' views about the experimental study, a majority of the students in the experimental group and the teachers considered the constructivist learning method as successful and found it necessary to apply this method to other lesson units in mathematics, to revise the curricula and the exam system in a way appropriate to this method as in elementary school education and to train teachers according to this system. Based on the present findings obtained as a result of the analyses of the data with respect to gender, schools (School A and School B) and groups (experimental and control) – which constituted the purpose of the study -, it is understood that the constructivist learning approach applied in trigonometry is more influential on increasing students' achievement in trigonometry, on maintaining the permanence of what has been learnt and on developing positive attitudes towards mathematics than traditional methods. Depending on the results of the present experimental study, the following suggestions could be put forward;

The national education policies should be revised in a way appropriate to the constructivist learning approach in secondary school education. In this respect, the curricula should be renewed considering practical aspects. Teacher candidates should be trained appropriately to the constructivist learning approach. Teacher-training institutions should be equipped with necessary materials and applications. Material-supported learning should be encouraged, and related applications should be controlled. The Provincial Directorate for National Education Tools should be recreated in towns, and teachers should be guided for material development and use. The Research and Development Directorate of the Ministry of National Education should give priority to practical studies and projects together with the constructivist learning approach in teaching secondary school courses. The number of studies on in-service training should be increased; for this purpose, local in-service training institutions should be established, and higher education institutions should be actively involved in these institutions. Since it takes more time to teach the lessons via the student-centered constructivist learning approach, some of the subjects included in the high school curriculum should be transferred to high education. Centrally-executed exams should be rearranged as appropriate to the constructivist learning approach. In order to teach the lessons in a way appropriate to the real life situations, the use of technologies, materials and calculators necessary for the lessons should be allowed.

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Genişletilmiş Özet

Bilimsel ve teknolojik alanda meydana gelen ilerlemeler toplumların hem yapısını hem de eğitim sistemlerini etkilemektedir. Bilgiyi sadece kullanan değil, bilgiyi üreten bireylerin yetiştirilmesinin önem kazandığı günümüzde, fen ve matematik eğitimcilerine daha büyük sorumluluklar düşmektedir (Akkoyunlu, 1996). Ülkemizdeki eğitim sistemi incelendiğinde çoğunlukla içe dönük kapalı bir sınıf ortamı; bir öğretmen ile bir gurup öğrenci, ders kitabı, sıra ve yazı tahtasından oluşan geleneksel bir yapıyla karşılaşılmaktadır (Başaran, 1993). Yapılandırmacı öğrenme yaklaşımı ile yapılan öğretim öğrencinin matematik başarı düzeyini geleneksel öğretime göre daha fazla arttırmaktadır (Erdoğan ve Sağan, 2002). Kısaca matematik öğretiminde materyal "problem çözme" düşüncesinden "problemi ortaya çıkarma" düşüncesine geçişi sağlayan çok güçlü bir öğretim aracıdır (Abromocivh, 1997). Türk ve İngiliz eğitim sistemlerinin karşılaştırılmasından matematik eğitiminde trigonometri konusunun ihmal edildiği sonucuna varılmıştır (Delice, 2003). Milimetrik kâğıt üzerinde açıların sinüs, kosinüs değerlerinin bulunup, trigonometrik cetvel haline dönüştürülebilir (Altun, 2005). Oluşturmacı öğrenme yaklaşımının öğrencilere kendi bildiklerini uygulama ve yeni bilgileri öğrenme fırsatı vermektedir (Rauff ve James, 1994) . Yapılandırmacı öğrenme yaklaşımının öğrencinin bilgiyi içselleştirmesine ve yeni bilgilere dönüştürmesine yardım eder (Halloway, 1999). Trigonometride temel kavramların öğrenilmesinde en büyük güçlüklerden biri; öğrencinin trigonometrik kavramları zihninde canlandırma yerine ezberlemeye meyilli olmasıdır. Buna da uygulanan sınav sisteminin de büyük payı vardır (İnan, 2006). Bu araştırmanın amacı; Biri devlet diğeri de özel lise olmak üzere, her lisede biri deney, diğeri de kontrol grubunda, trigonometrinin giriş ünitesi olan trigonometrik temel kavramları, deney grubunda yapılandırmacı öğrenme yaklaşımıyla kontrol grubunda ise geleneksel öğretim yöntemi ile işlenmesi sonucunda grupların başarı ve tutumlar arasındaki farkların istatistiksel açıdan anlamlı olup olmadığını araştırmaktır Alt amaç olarak deneysel çalışmada uygulanan öğretim materyallerinin öğretim ortamına etkisi, Ardahan tarafından geliştirilen materyal değerlendirme formu ile deneysel çalışmaya yönelik öğretmen ve öğrenci görüşlerinin değerlendirilmesi ise mülakat formu ile gerçekleştirilmiştir.

Deneysel çalışma öncesinde başarı testi ile matematiğe karşı tutum ölçeği uygulandı. genel olarak ve okullar ayrı ayrı değerlendirildiğinde deney ve kontrol grupların ön testleri arasında anlamlı bir fark oluşmadığı ($P>0.05$), (Tablo 1) deney ve kontrol gruplarının çalışma öncesinde denk başarı ve benzer tutum sahip oldukları şeklinde yorumlanabilir. Çalışmandan verimli sonuç alınması amacıyla bizzat araştırmacı tarafından dört hafta (haftada 4 saat) ders anlatıldı. Bu anlatım sonunda deney ve kontrol gruplarının başarı ve matematiğe karşı tutumlarında bir değişiklik olup olmadığını ölçmek amacıyla bir başarı testi ile tutum ölçeği uygulandı. Deney gruplarında tutum ve başarıları arasında son testler lehine anlamlı fark oluştuğu ($P<0.05$). Bu durumunda yapısalcı öğrenme yaklaşımının deney guruplarında etkili olduğu ve matematiğe karşı tutumlarında olumlu değişikliklerin meydana geldiği. Kontrol grubunda ise tutumlarında anlamlı fark olmadığı fakat başarıları arasında anlamlı fark belirlendi. Geleneksel öğretim metodunun öğrencilerin matematiğe karşı tutumlarında bir değişiklik yaratmadığı başlangıç tutumlarını koruduğu şeklinde yorumlanmıştır. Bu sonuç Dikkarten ve Uyangör (2007) ile Erdoğan ve Sagan (2002) çalışmaları paralellik göstermektedir. Bu aşamaya kadar tartışılan başarı ve tutum düzeylerinin kalıcılığı konusunda durumu belirlemek için deney çalışmasından bir ay sonra başarı ölçeği aynı gruplara tekrar uygulandı. Deney ve kontrol guruplarında son testler - hatırda tutma testleri arasında başarı bakımından incelendiğinde deney ve kontrol guruplarında başarıları arasında anlamlı fark olmadığı, görülmektedir. Bu durum deney ve kontrol gruplarında deney sonrası düzeylerini korudukları bilgilerin kalıcılığı bakımından deney gurubunun daha iyi olduğu ($0.40>0.31$) söylenebilir (Tablo 4). Deney ve kontrol gruplarında cinsiyete göre bağımsız olarak son testleri karşılaştırıldığında, başarı ve tutum bakımından anlamlı fark oluşturmadığı, bu durumda deney ve kontrol gruplarındaki öğrencilerin deney sonrası başarı ve tutum bakımından denk oldukları söylenebilir (Tablo 5). Bu sonuç genelde kız öğrencilerin başarılı oldukları görülmüş ve öğrenim düzeyi yükseldikçe artış gözlenmiştir" şeklinde özetlenen (Ubuz, 1999) çalışmasını desteklememektedir.

Deney ve kontrol grupları birlikte cinsiyete göre başarı ön/son ve matematiğe yönelik tutum ön/son testleri karşılaştırıldığında; deney ve kontrol gurubu başarıda cinsiyete göre anlamlı fark, ($P<0.05$) fakat matematiğe yönelik tutumlarında anlamlı fark olmadığı ($p>0.05$) gözlenmektedir (Tablo 6). Bu sonuç (Baki ve Özpınar 2007) çalışmasını desteklemektedir. Okullara göre deney ve kontrol gruplarının başarı ön/son ve matematiğe yönelik tutumları ön/son testleri karşılaştırıldığında iki okulda deney ve kontrol gruplarında öğrencilerin başarılarını artırdığını fakat matematiğe yönelik tutumlarında ise sadece deney grubunda olumlu değişiklikler meydana geldiği ve bu durumun uygulanan yapılandırmacı öğrenme

yaklaşımından kaynaklandığı düşünülebilir. Okullara göre deney ve kontrol gruplarının başarı son/ başarı hatırda tutma testlerinin verileri incelenerek başarının kalıcılığı ile farkları karşılaştırıldığında öğrencilerin genellikle öğrendikleri bilgi düzeylerini koruduklarını şeklinde yorumlanmıştır (Tablo 7).

İki okulun ayrı ayrı deney ve kontrol gruplarının cinsiyete göre başarı ön/son matematiğe yönelik tutum ön/son testlerinin karşılaştırılmasında edilen sonucun cinsiyete göre de değişmediği yani deney gruplarının genel olarak veya cinsiyete göre yapılandırmacı öğrenme yaklaşımı ile başarılarının artığı, matematiğe yönelik tutumlarında olumlu anlamda değişiklik meydana getirdiği görülmektedir. İki okulun ayrı ayrı deney ve kontrol gruplarının son\hatırda tutma testlerinin karşılaştırılmasından; özel okullar daha başarılıdır yaygın kanaatini desteklememektedir.

Alt amaçlardan olan Deneysel çalışmada uygulanan öğretim materyallerinin öğretim ortamına etkisine bakıldığında, öğrencilerin % 61'lik kısmı materyal hakkında olumlu görüş, % 30'luk kısmı da eksiklikleri giderilirse daha iyi olabileceğini belirtmesi materyallerin % 90 oranında kabul gördüğünü göstermektedir. Bu sonuç (Ardahan ve (Ersoy / Aslan ve Ardahan, 2003) çalışmasının sonuçları ile benzerlik, (Olkun ve Altun, 2003) , Durmuş ve Yaman 2006) , (Erkan, 2006) ve (Kayahan, 2006) çalışmalarını destekler nitelik göstermektedir. Bu deneysel çalışmanın sonuçlarından hareketle **aşağıdaki öneriler** sunulabilir;

Orta öğretimde yapılandırmacı öğrenme yaklaşımı ile ele alınabilecek daha birçok ünite olduğundan bu alanda yeni çalışmalar desteklenmelidir. Milli eğitim politikasının orta öğretimde de yapılandırmacı öğrenme yaklaşımına uygun olarak yeniden gözden geçirilmelidir. Bu çerçevede; Ders müfredatları uygulamaya dönük olarak yenilenmelidir. Öğretmen adayları yapılandırmacı öğrenme yaklaşımına uygun olarak yetiştirilmelidir. Öğretmen yetiştiren kurumlar daha donanımlı hale getirilmelidir. Materyal destekli öğrenme teşvik edilmeli uygulamalarda sıkı bir şekilde denetlenmelidir. İl Milli Eğitim Araçları Başkanlıkları ilçelerde de olmak üzere yeniden ihdas edilerek, öğretmenlere materyal geliştirme ve kullanma konusunda rehberlik yapılmalıdır. Milli Eğitim Bakanlığı Araştırma ve Geliştirmeyi Destekleme Başkanlığı orta öğretim konularının yapılandırmacı öğrenme yaklaşımı ile uygulamaya dönük proje ve çalışmalara öncelik vermelidir. Hizmet içi eğitim çalışmalarının yaygınlaştırılması ve bu çerçevede bölge hizmet içi eğitim kurumları ihdas edilmelidir. Bu kurumlarda yükseköğretim kurumları aktif olarak görev almalıdır. Öğrenci merkezli yapılandırmacı öğrenme yaklaşımı ile ders yapılması daha fazla zaman aldığından, lise müfredatındaki bazı konuların yükseköğretime aktarılmalıdır. Merkezi sınavlar yapılandırmacı öğrenme yaklaşımına uygun olarak yeniden düzenlenmelidir. Derslerin günlük hayata uygun verilerle işlenmesi için dersin ve ünitenin ihtiyacı kadar teknoloji, materyal ve hesap makinelerin kullanılmasına izin verilmelidir.

Citation Information

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