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A Meta-Analysis on Instructional Applications of Constructivism in Science and Technology Teaching: A Sample of Turkey *

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Abstract

In this study, the meta-analysis technique has used to aimed to achieve a comprehensive vision on quality will lead to new study about instructional applications of constructivism have effectiveness on the achievement and attitude of science and technology lesson according to the research that took place in Turkey between the years 2002-2012. As a part of this study, determined inclusion criteria for the collection of data coding form was prepared. Within the scope of the study; 25 doctoral dissertations, 77 scholarly articles in total 102 investigations were examined. 31 experimental and quasi-experimental studies which were found suitable for inclusion criteria are combined with meta-analysis. Each studies' effect size which were included in the meta-analysis is calculated by using statistical software CMA (Comprehensive meta-analysis) according to Cohen's d. According to the results, student-centered activities are determined to be more effective than traditional activities for increasing the achievement of science and technology lesson on a large level (ES=1.003); in developing a positive attitude for the science/science and technology lesson with a medium level (ES=0.743). In addition, student-centered activities are determined to be more effective than the traditional activities for increasing the achievement of science and technology lesson in all disciplines of science on a large level (on the subjects of Physics, ES=1.025; on the subjects of Chemistry, ES=1.087; on the subjects of Biology, ES=0.923), developing a positive attitude of science/science and technology lesson on a medium level on the subjects of Physics (ES=0.473); and a large level on the subjects of Chemistry (ES=0.843) and Biology (ES=0.970). Besides, the findings show that the studies that have been included in the analysis, have no publication bias. Suggestions have been made for issues to be considered on science teaching research to be carried out and meta-analysis issues' necessity to be studied.

Keywords

Meta-analysis

Instructional applications of constructivism

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Introduction

Individuals who attain the quality and the norms by means of science who plays key role in terms of growing in the society (Ayas et al., 2005) carries a lot of weight (Geraedts, Boersma, & Eijkelhof, 2006). In this respect, Turkey works to determine deficiencies needing to be removed in education and precautions needing to be taken by joining international investigations like PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) with the aim of attaining the quality called for in science. In evaluation of the working TIMSS-R (Third International Mathematics and Science Study-Repeat) 1999, it emerged that the achievement of science was not at the desired level (EARGED, 2003; Şişman, Acat, Aypay, & Karadağ, 2011). In accordance with the concept of student-centered constructivist approach was seen appropriate after curriculum of science and technology lesson had been renewed in 2004 (MEB, 2004, 2006).

When TIMSS 2007 and TIMSS 2011 results obtained after curriculum based on instructional applications of constructivism were put into practice are examined; Turkey's average science achievement in the TIMSS 1999, increased by 21 percentage points (Şişman et al., 2011). Although in TIMSS 2011, improvement of science scores but also 4th and 8th grade achievement scores on average, remained below the TIMSS scale average. So it has been seen that the progress in scientific achievement from 1999 till 2011 is limited (ERG, 2011a; Şişman et al., 2011). However, according to PISA results, Turkey has been the OECD country which got the highest score increased on scientific literacy test between 2006 and 2009. The students who participated in science literacy test of PISA success only showed superior 1%, remained below the basic skill level of 30%. In spite of important score increment, there has not been progress on the number of student with superior performance (EURYDICE, 2011; ERG, 2011b; Özenç & Arslanhan, 2010). Although science and technology lesson have innovated comprehensive changes on curriculum of late years in Turkey, it is necessary to investigate either new curriculum are being implemented correctly or not. In this respect, original studies about effective science teaching carry a lot of weight.

Ceylan (2009) states that instructional applications of constructivism are applied more at schools with low achievement than ones with high performance. This result of last years, seems unexpected when approaches to science teaching are looked at; however, it shows consistency with studies done by using international data. For example, at studies done by using the data of TIMSS (1999) and PISA (2009), it has been put forward that there is a negative relationship between instructional applications of constructivism and achievement of students (Aypay, Erdoğan, & Sözer, 2007; Ceylan & Berberoğlu, 2007). Nevertheless, when the frequency of activities at science lesson of countries like Singapore, Japan and Hong Kong which show high achievement at international work is investigated, it is seen that activities based on student are applied less to science lesson in these countries (Pelgrum & Plomp, 2002 as cited in Ceylan & Berberoğlu, 2007). Furthermore, in some studies, it has been found that instructional applications of constructivism do not make significant difference to increase achievement with respect to traditional methods (Demirel, Şahan, Ekinci, Özbay, & Begimgil, 2006; Timur & Kıncal, 2010; Saygılı, 2010; Serin, 2009; Umdu Topsakal, 2010; Ural, 2009). On the other hand, by contrast with findings of this studies, as to so much work at literature, it has been discovered that instructional applications of constructivism during science and technology lesson affect student achievement positively (Akçay, Aydoğdu, Yıldırım, & Şensoy, 2005; Aydede & Matyar, 2009; Balım, 2009; Bozkurt, Orhan, Keskin, & Mazi, 2008; Candan, Türkmen, & Çardak, 2006; Çetin & Günay, 2007; Çırakoğlu & Saracaloğlu, 2009; Doymuş, Aksoy, Daşdemir, Şimşek, & Karaçöp, 2006; Demirci, 2010; Demirci & Çınkı, 2009; Gençosman & Doğru, 2012; Güven, 2009; Güven & Sülün,

2012). In conclusion, it is seen that different results are obtained during experimental studies which look at learning-teaching activities' effect on science achievement.

On the other hand, it is seen that attitudes towards lesson are frequently examined at science teaching. The attitude plays an important part on materialization of learning because it influences decisions and behaviors of students (Altınok & Açıkgöz Ün, 2006). There are a lot of studies which show that students' attitudes towards science contribute their science achievement positively (i.e., Ceylan, 2009; Freedman, 1997; Oruç, 1993; Serin & Mohammadzadeh, 2008; Turhan, Aydoğdu, Şensoy, & Yıldırım, 2008). Therefore, the attitude towards lesson carries so much weight for increasing achievement during science and technology lesson. Studies who examine learning-teaching activities' effect on the attitude towards science and technology lesson at science teaching have abundant wealth. It has concluded that contemporary teaching-learning activities improve the attitude during science and technology lesson in some of these studies (Altınok & Açıkgöz Ün, 2006; Aydın & Yılmaz, 2010; Bilen & Aydoğdu, 2010; Çetin, 2010; Çıbık Sert, 2009; Efe & Bakır, 2006; Gök, Doğan, Doymuş, & Karaçöp, 2009; Ören & Tezcan, 2009; Tatar & Kuru, 2009; Umdu Topsakal, 2010; Yılmaz & Huyugüzel Çavaş, 2006), but at some of them, they don't make significant difference according to traditional approaches (Akamca & Hamurcu, 2005; Çelik, Eroğlu, & Selvi, 2012; Demirel et al., 2006; Keleş, 2009; Özsevgeç, 2006; Saygılı, 2010; Serin, 2009; Şahin, Öngören, & Çokadar, 2010; Tok, 2008; Uzun, 2010; Ünal & Ergin, 2006). Therefore, it can be said that there are differences at results of studies which examine learning-teaching activities' effect on the attitude towards science and technology lesson.

As is known, studies include different variables, methods, samples and patterns that is why their results could conflict with one another (Wolf, 1986). Small-scale studies can rarely give certain answers. The necessary thing in this situation is to be able to give meaning to so many accumulated findings, not to increase new studies, this is possible with meta-analysis. The meta-analysis of accumulated literature shows that the findings are not contrary to each other as it is thought, and generalizations can be found from previous studies (Cavanaugh, 1998; Hunter & Schmidt, 1990).

In Turkey, to access numerous studies in the field of science teaching which are done separate from each other, repetitive or attain results that are different from one another becomes possible. When the number of studies which are done increases, it gets hard for readers to be able to overcome this data base, access information they want, and naturally see the "big picture". To interpret this data base and cause new studies, inclusionary and reliable studies are needed (Akgöz, Ercan, & Kan, 2004).

When meta-analysis studies which are carried out about learning-teaching activities in Turkey and the other countries are examined, it is seen that these studies (Johnson, Johnson, & Stanne, 2000; Kablan, Erkan, & Topan, 2013; Kaşarcı, 2013; Kulik, Schwab, & Kulik, 1982; Marzano, Pickering, & Pollock, 2001; Tarım, 2003) included "all class levels and lessons". In meta-analysis studies which incorporate studies on science and technology lesson and their sub disciplines physics, chemistry and biology lessons, it is seen that studies which "only one teaching-learning activity at all class levels" is examined (Acar, 2011; Armağan Öner, 2011; Bayraktar, 2002; Smith, 1996; Zhou, 1995) are included in meta-analysis. In studies which "different learning-teaching activities that can congregate under particular understanding" are accepted as independent variable (Marzano et al., 2001; Zhou, 1995), studies which are done at all class levels have been combined by way of meta-analysis. As a result, a study which "different learning-teaching activities that can congregate under particular understanding and at particular class levels on science teaching" are addressed as inclusion criteria has not been come across. In this sense, to combine and interpret findings regarding science teaching have got an importance in terms of seeing the "big picture".

The Aim of Research

The aim of this study is to acquire a general opinion regarding the effect of instructional applications of constructivism on attitude towards science and achievement of science and technology lesson, through meta-analysis which were applied and published between the years 2002 and 2012 in Turkey. Towards this aim, answers have been sought for problems below.

1. According to studies which were done in the field of science teaching at elementary education between the years 2002 and 2012, what is the effect size of instructional applications of constructivism on science achievement?
2. According to studies which were done in field of science teaching at elementary education between the years 2002 and 2012, what is the effect size of instructional applications of constructivism on the attitude towards science and technology lesson?
3. At studies which were done in the field of science teaching at elementary education between the years 2002 and 2012, what is the effect size of instructional applications of constructivism on science achievement when it is looked at in terms of physics, chemistry and biology issues?
4. At studies which were done in the field of science teaching at elementary education between the years 2002 and 2012, what is the effect size of instructional applications of constructivism on the attitude towards science and technology lessons when it is looked at in terms of physics, chemistry and biology issues?

Method

For the purposes of above, studies which test the effect of instructional applications of constructivism on students' academic achievement and attitudes at science and technology teaching have been done meta-analysis (Glass, 1976).

Data Collection

In this meta-analysis study, doctoral dissertations published about subject that will be analyzed and scholarly scholarly articles published in refereed journals are taken advantage.

Inclusion Criteria

Criteria which are used to choose studies included in meta-analysis are related to being within study limits and possessing statistic data which are necessary for analysis (Wolf, 1986). Inclusion criteria used in this study and descriptions relating to these criteria are given in Table 1.

Table 1. Descriptions Relating Inclusion Criteria

Inclusion Criteria	Description
1. Science teaching	Being a research conducted in the field of science teaching
2. Application and publication years	Both to be applied and published between the years 2002-2012
3. Examining the effect on the student achievement	Examining the students' academic achievement as the dependent variable
4. Examining the attitude towards science and technology lesson/science	Examining the students' attitude towards science and technology lesson/science as the dependent variable
5. Learning-teaching activities (instructional applications of constructivism)	Computer based learning, cooperative learning, discovery learning strategy, project based learning, research-inquiry based learning, multiple intelligences, problem based learning, constructivist applications, learning circle, 5E, active learning.
6. Including control groups	Having a control group to calculate the effect size.
7. Including enough numerical data	Having standard deviation, mean and the sample size of the data to calculate the effect size.

Table 1. Continue

Inclusion Criteria	Description
8. Usage of traditional learning-teaching activities in control group	Having been used of traditional learning-teaching activities (expository learning and expression) in control group.
9. Having been fulfilled at secondary school grades	5th, 6th, 7th and 8th grades.
10. Treatment time	Treatment time takes at least four weeks.

Coding Method

This information has been targeted to reach from encoders by using coding form that is composed according to the aim of study: Reference information, sample or working group's features, experiment group's features, control group's features, method's features, information regarding effect size. Studies whose encoding is done by authors are also sent to three encoders. Studies have been examined towards codings which other coders, criticisms, suggestions and necessary adjustments have been made.

According to last browsing whose date is January 20, 2013, total of 102 studies which are 25 doctoral dissertations and 77 scholarly articles reached by inclusion criteria are taken into consideration. When detailed coding of these studies is done, 31 of them are found appropriate for meta-analysis. So as to generate a perspective concerning how the extent of this meta-analysis work is narrowed; in other words, how it is delimited, information towards study that is examined is as follows:

Considering the examine the situation of achievement and attitude variables on to studied physics, chemistry, biology topics, it is seen that the study examined don't concentrate on a particular science discipline or a subject (see Table 2).

Table 2. The Number of Studies That Included in Meta-Analysis According to the Studied Topics and Examining Situation of Achievement and Attitude Variable

	Class level	The number of studies examining the achievement variable	The number of studies examining the attitude variable	The total number of study
Physics topics				
Voice and light	5	2	1	3
Force and motion	7	2	2	4
If the pressure would not exist	7	3	1	3*
The pressure of liquids and gases	7	1	1	1*
Magnetism	8	1	1	1*
Electricity in our lives	7	1	-	1
Total		10	6	13
Chemistry topics				
The particulate nature of matter	6	1	-	1
Structure and properties of matter	7	2	2	2*
Matter and heat	6	1	1	1*
Acids and bases subject	8	1	-	1
Matter and change	5	1	1	1*
Structure and properties of matter	8	2	1	2*
Total		8	5	8

Table 2. Continue

	Class level	The number of studies examining the achievement variable	The number of studies examining the attitude variable	The total number of study
Biology topics				
Our blue planet that all living things' common home getting to know and preserve	7	2	2	2*
Flowering plants subject	6	1	-	1
Reproduction and development of living things	6	2	1	2*
reproduction	8	1	-	1
Matter and energy for living things subject	8	2	2	2*
Support and motion system, digestive system, respiration system, circulation system, blood groups and excretory system topics	6	1	-	1
Genetic	8	1	-	1
Total		9	5	10

* In some studies attitude and achievement variables are examined together. So the total number of study seems different.

According to the science and technology curriculum units located at grade level of each learning area are given in Table 3. The shaded areas represent units studied in the research were included in the meta-analysis.

Table 3. Science and Technology Units Being Studied on According to Class Levels in Studies Included in Meta-Analysis

Learning Area	**Grade 5**	**Grade 6**	**Grade 7**	**Grade 8**
	Units			
The Living and Life	- Let's solve the riddle our bodies - Recognize and travel of world of living thigs	- Reproduction and development of living things - Systems of our bodies	- Systems of our bodies -Human and environment	- Cell division and heredity -Relations of living things and energy
Matter and Change	-Change and recognition of Matter	- The particulate nature of matter -Matter and heat	- Structure and properties of matter	- Structure and properties of matter -State of matter and heat
Physical Phenomenons	- Force and Motion -Light and voice - Electricity of Our Lives	- Force and Motion - Voice and Light - Electricity of Our Lives	- Force and Motion -Light - Electricity of Our Lives	- Force and Motion -Voice - Electricity of Our Lives
The Earth and The Universe	- Earth Sun and Moon	- What Constitutes Earth Crust	- Solar System and Beyond	- Natural Processes

According to Table 3, the learning area which is mostly worked on at all class levels is ''Material and Change''. There are not any studies at fifth and eighth class level relating to ''The Living and Life'' learning area, at sixth class level relating to ''Physical Phenomenons'' learning area and in any units relating to ''The Earth and The Universe'' learning area. The reason of this situation could be that teachers cannot manage to fulfill subjects concerning relevant units because of the fact that units relating to learning areas mentioned take place at the end of curriculum.

According the teaching-learning activities being tested their effectiveness; the number of study that examining achievement, attitudes variables, and conducted on the subject of physics, chemistry and biology topics are given in the Table 4. Learning-teaching activity which is mostly worked on is cooperative learning. While three studies have been done about research based learning and computer based learning, there are two studies which have been carried out about the other learning-teaching activities (see Table 4.). General information about examining studies are given in Table 5.

Table 4. According to Teaching and Learning Activities, The Number of Study That Examining Achievement, Attitude Variable and Conducted on Physics, Chemistry and Biology Topics

Teaching-Learning Activities	The number of study that examining the achievement variable	The number of study that examining the attitude variable	The number of studies conducted on physics topics	The number of studies conducted on chemistry topics	The number of studies conducted on biology topics	Total number of study
1.Computer based learning	3	1	-	1	2	3
2.Cooperative learning	8	5	5	1	3	9
3.Discovery learning	2	1	2	-	-	2
4.Project based learning	2	1	2	1		3
5.Research -Inquiry based learning	3	1	2	-	1	3
6.Multiple intelligences	2	2	1	2		3
7.Problem based learning	2	2	-	2	-	2
8. Constructivist instructions : Game-experiment-simulation-case study)	1	1	-	-	1	1
9.Learning circle	2	1	2	-	1	3
10.Active learning	2	1	-	1	1	2
Total	27	16	14	8	9	31

Table 5. Information About Included Studies in the Meta-analysis

	Variable	f	%
The year study was published	2002	1	3.2
	2003	1	3.2
	2004	2	6.5
	2005	2	6.5
	2006	5	16.1
	2007	3	9.7
	2008	2	6.5
	2009	5	16.1
	2010	4	12.9
	2011	1	3.2
	2012	5	16.1
The year application was performed	2002-2003	5	16.1
	2003-2004	1	3.2
	2004-2005	6	19.4
	2005-2006	4	12.9
	2006-2007	5	16.1
	2007-2008	1	3.2
	2008-2009	1	3.2
	2009-2010	1	3.2
	2010-2011	1	3.2
	2011-2012	-	-
	Unknown	6	19.4
Discipline	Physics	13	41.9
	Chemistry	8	25.8
	Biology	10	32.3
Data group	Achievement	16	51.6
	Attitude	4	12.9
	Achievement and Attitude	11	35.5
Class level	Grade 5	4	12.9
	Grade 6	5	16.1
	Grade 7	13	41.9
	Grade 8	9	29.0
Place where applications is done	Adana	1	3.2
	Ankara	7	22.6
	Çanakkale	2	6.5
	Denizli	2	6.5
	Erzurum	1	3.2
	Eskişehir	1	3.2
	Hatay	1	3.2
	İzmir	6	19.4
	Kastamonu	1	3.2
	Sakarya	1	3.2
	Şanlıurfa	1	3.2
	Batman	1	3.2
	Yalova	1	3.2
	Bilinmiyor	4	12.9
	Ege bölgesi	1	3.2
Published type	Articles	26	83.9
	Doctoral dissertations	5	16.1
Research Design	Experimental	19	61.3
	Quasi-experimental	12	38.7
Treatment time	4-5 weeks	12	38.7
	6-7 weeks	8	25.8
	8 and up	11	35.5

According to Table 5 in studies included in meta-analysis, it is seen that applications were achieved mostly in 2004-2005 (19.4 %) academic year. The publication number is more in the years 2006-2012 (16.1 %). Moving on instructional applications of constructivism in 2004-2005 academic year could be the reason for this situation. 13 studies and physics subjects at the most have been worked on and application at seventh class level has been done. 26 of the studies are article and five of them are doctoral dissertations. The reason why the number of dissertations is fewer compared to the number of published studies is that activities based on existing curriculum instead of traditional teaching activities are carried out in doctoral dissertations at control group. Because of that, related dissertations have been accepted from the research. When it is examined in respect to the place which the application is done, it is seen that mostly studies in Ankara and İzmir cities have been done. It is seen that measuring devices are improved by scholars in all studies to evaluate achievement but measuring device improved before is used for the attitude towards science and technology in general.

Data Analysis

Measurement Type of Effect Size and Interpretation

In this study, effect size of every study included in meta-analysis has been computed according to Cohen's *d* which is one of measurement types of effect size for two independent groups. Interpretation of effect size has been done according to classification by Cohen (1988) with Thalheimer and Cook (2002) for effect size level's semantic expression. Sample size of this meta-analysis research is big enough (n >20) and there are not any meta-analysis studies about related subject at science teaching in Turkey so usage of Cohen's *d* formula has been preferred. Thus, adequacy of sample size can be estimated and the level of effect size acquired can be commented on more comprehensibly (Özsoy & Özsoy, 2013).

Statistics Program in Use

In this study, effect sizes and variances concerning every study included in meta-analysis, groups' combined effect sizes and groups' comparisons have been computed with CMA (comprehensive meta-analysis) statistics program.

Homogeneity Test and Statistical Model Used in Meta-Analysis

Homogenity of studies included in meta-analysis have been evaluated according to Q statistics results (Borenstein, Hedges, Higgins, & Rothstein, 2009; Hedges & Olkin, 1986). Whether combining studies included in meta-analysis work is appropriate statistically or not has been given by way of presented distribution of effect sizes' confidence intervals visually (Cumming & Finch, 2005). Diagram which boxes (squares) are used has been preferred for presentation of effect sizes in this study. This presentation provides some advantages in comparison with diagram in which lines are used. Boxes symbolize a visual sign, become prominent and provide effect of different studies to be seen more quickly and easily (Borenstein et al., 2009).

In this study, combined effect size according to the random effects model has been computed. The reasons why this model has been chosen are as follows: Firstly, the answer of question "Can methods applied for effect prediction in this study be useful for average?" is looked for. Secondly, hypothesis of mutual effect size isn't satisfied because subjects and interfering effects in these studies will affect the results somehow. In this case, the random effects model is confirmed more easily than the fixed effects model (Borenstein et al., 2009).

Determination of Publishing Bias

First of all, a funnel plot which gives the answer for the question "Is there an evidence of bias?" has been used for determining publishing bias (Borenstein et al., 2009; Copas & Shi, 2000; Long, 2001). Begg-Mazumdar and Egger tests regarding bias indicators have been done to quantify prejudice amount found by the funnel plot because commenting diagram is quite subjective (Rothstein, Sutton, & Borenstein, 2005). The Rosenthal method and the Orwin (1983) method have been utilized to be able to give answer to the question "How strong is the bias and what is the effect on the results?" and to determine fail-safe number which will render meaningless the effect size found (Borenstein et al., 2009). Furthermore, assessment has also been done by comparing average effect size of studies published with average effect sizes of studies not published.

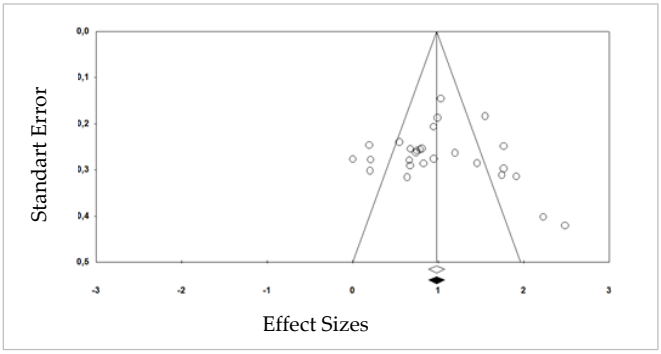
Findings

1. Findings Regarding the Effect of Instructional Applications of Constructivism on Science Achievement

Data of 27 studies have been combined for the purpose of finding answer to the first question. According to the random effects model, data in studies included in meta-analysis have been calculated as standard error is 0.105, upper limit of 95% confidence interval is 1.208 and lower limit is 0.797 and effect size value is ES=1.003 (Wolf, 1986; Hunter & Schmidt, 1990; Rosenthal, 1991; Lipsey & Wilson 2001). It has been calculated that the value of Q-statistics homogeneity test is 32.474 (Lipsey & Wilson, 2001). Homogeneity belonging to distribution of effect sizes has been accepted in the random effect model because the value of Q-statistics homogeneity test doesn't exceed the critical value of the chi-square distribution for 26 degree of freedom. According to the random effects model, 1.003 average effect size value expresses an effect size in large level and positively with respect to classification of Cohen (1988) with Thalheimer and Cook (2002). According to this, instructional applications of constructivism can be said to be more effective than traditional ways to a great extent on the subject of increasing academic achievement towards science and technology lesson. This result is consistent with Turkish scholars which are done towards effect on achievement of science and technology lesson of learning-teaching activities in different years (Akçay et al., 2005; Atay Doğru & Tekkaya, 2008; Aydede & Matyar, 2009; Balım, 2009; Buzludağ & Yılayaz, 2012; Doymuş, Şimşek, & Bayrakçeken, 2004; Efe & Bakır, 2006; Çelik et al., 2012; Gençosman & Doğru, 2012; Gök et al., 2009; Güven & Sülün, 2012; Kıncal & Ergül, 2007; Korkmaz & Kaptan, 2002; Süzen, 2007; Tatar & Kuru, 2009; Timur & Kıncal, 2010; Ulu, 2011). Additionally, this finding also confirms the findings of meta-analysis studies which have been done in Turkey and in other countries to check the effect on achievement of science and the findings of learning-teaching activities accepted as instructional applications of constructivism (Armağan Öner, 2011; Johnson et al., 2000; Kablan et al., 2013; Kaşarcı, 2013; Tarım, 2003; Zhou, 1995).

Publishing Bias of Studies Which Examine Achievement Variable Included in Meta-Analysis

It could be said that there is no publication bias at the funnel plot which congregate around a center and show symmetrical distribution (Copas & Shi, 2000; Long, 2001). Funnel plot of effect sizes belonging to studies included achievement variable is given at Shape 1.



Shape 1. Funnel Plot of Effect Sizes Belonging to Studies Included Achievement Variable

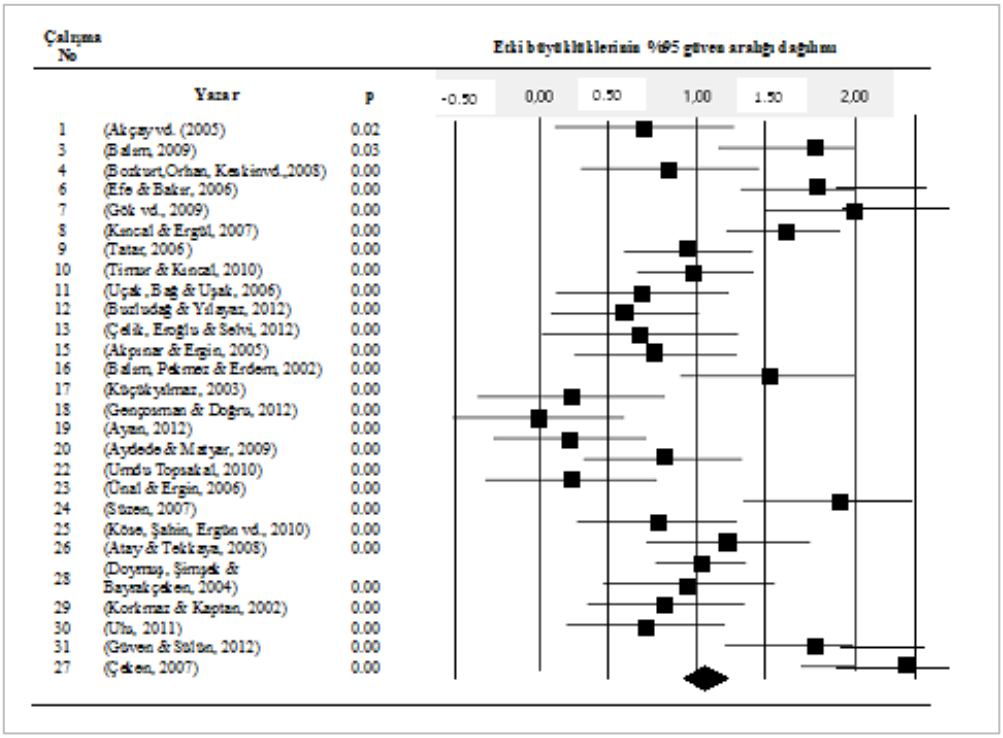
When Shape 1. is examined, it is seen that effect size distributions of studies inspecting achievement variables do not show a symmetrical distribution. The funnel plot presents a visual feeling of relation between the effect size and sensibility, but commenting this graph is highly subjective (Rothstein et al., 2005). Therefore, when Begg-Mazumdar and Egger tests concerning bias indicators are evaluated with the aim of evaluating prejudice amount which is found by funnel plot, Begg-Mazumdar Kendall's tau = 0.099 p=0.465 and Egger: bias = 0.998 (95% CI = -2.751 to 4.747) p=0.588 have been detected. Both analysis show that bias is not significant (Rothstein et al., 2005). When the influence on average effect size of publishing situations of studies included in studies for achievement variable is examined, it has been found that published studies' effect size is 1.017 and unpublished studies' effect size is 0.952 (Wolf, 1986; Borenstein et al., 2009). According to publishing

situations, both of the medium effect sizes have large effect with respect to Cohen (1988) with Thalheimer and Cook's (2002) classification.

Fail safe number acquired from this meta-analysis study is 2758 according to the Rosenthal method. In other words, there should be research which has got contrary values to least 2758 sum of findings in litterateur in order that these meta-analysis findings consisting of 27 studies' data become invalid. According to Orwin (1983) method, number of research needing to be included in meta-analysis has been found 108 in order that average effect size acquired from the result of this meta-analysis (EB=1.003) decreases to effect size at small level (EB=0.2) at Cohen's (1988) classification. When fail safe numbers acquired with both methods are looked at, it could be said that this meta-analysis study is reliable.

Confidence Intervals *Distribution of Studies' Effect Sizes Examining Achievement Variable*

Statistical availability of combining studies through meta-analysis depends on studies' effect sizes included in research show a consistent distribution in their own right. That the confidence intervals are narrow shows measurement has been done with less tolerance and finding is more reliable. Studies whose power and sensibility are high give narrower confidence intervals and more reliable results (Murphy & Myors, 2004). When studies' 95% confidence intervals included in meta-analysis do not contain an invalid value, p value becomes under 0.05. In this respect, confidence intervals distributions of studies' effect sizes examining achievement variables have been given at Shape 2.



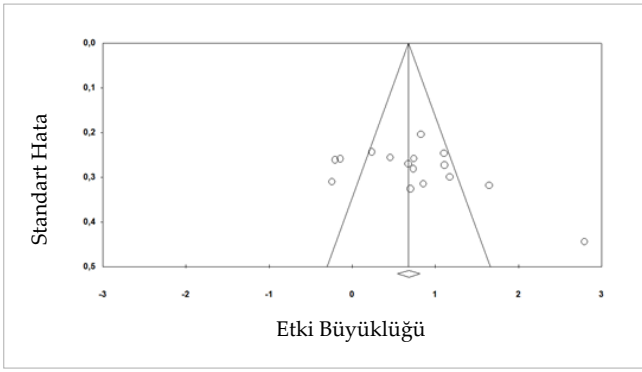
Shape 2. Confidence Intervals of Studies' Effect Sizes and Their Weights' Diagram Which Examining Achievement Variables

2. Findings Concerning Effectiveness on The Attitude Towards Science and Technology Lesson of Instructional Applications of Constructivism

Data of 16 studies have been combined for finding answer to the second question. Data in studies included in meta-analysis according to the random effects model have been determined as 0.155 standard error and 95% confidence intervals' upper limit 0.438 and lower limit 1.048 with effect size's value ES=0.743. The value of Q-statistics homogeneity test is 19.503 (Lipsey & Wilson 2001). In order that this value doesn't exceed to 24.995 which is the critical value for 15 freedom degree at 95% significance level from χ^2—table (Spiegel, 1961), effect sizes' distribution has appeared to have a homogeneous feature. 0.743 average effect size value found according to the random effects model has an medium effect according to Cohen (1988) with Thalheimer and Cook's (2002) classification [Cohen (1988) has determined effect size that between 0.0 and 0.4 is small, between 0.5 and 0.8 is medium and above 0.8 is large. According to Thalheimer and Cook (2002), between -0.15 and 0.15 unimportant, between 0.15 and 0.40 small, between 0.40 and 0.75 medium, 0.75 and 1.10 large, between 1.10 and 1.45 very large, above 1.45 enormous level.] Accordingly, instructional applications of constructivism can be said to be more effective than traditional ways on medium level on the subject of increasing academic achievement towards science and technology lesson. This result shows consistency with Turkish studies done in different years (Akpınar & Ergin 2005; Altınok & Açıkgöz Ün, 2006; Çelik et al., 2012; Çıbık Sert, 2009; Doymuş et al., 2004; Köse, Şahin, Ergün & Gezer, 2010; Gök et al., 2009; Şaşmaz Ören, & Tezcan 2009; Tatar & Kuru, 2009; Uçak, Bağ, & Uşak, 2006). Additionally, this result also confirms the findings of meta-analysis studies which have been done in Turkey and in other countries to check the effect on the attitude towards science and technology lesson of learning-teaching activities accepted as instructional applications of constructivism (Acar, 2011; Kaşarcı, 2013; Zhou, 1995).

Publishing Bias of Studies Which Examine Attitude Variable Towards Science and Technology Lesson Included in Meta-Analysis

As mentioned before, one of the best and easily comprehensible methods to see the effect of publications' sample sizes on the results are the funnel plot (Copas & Shi, 2000; Long, 2001).



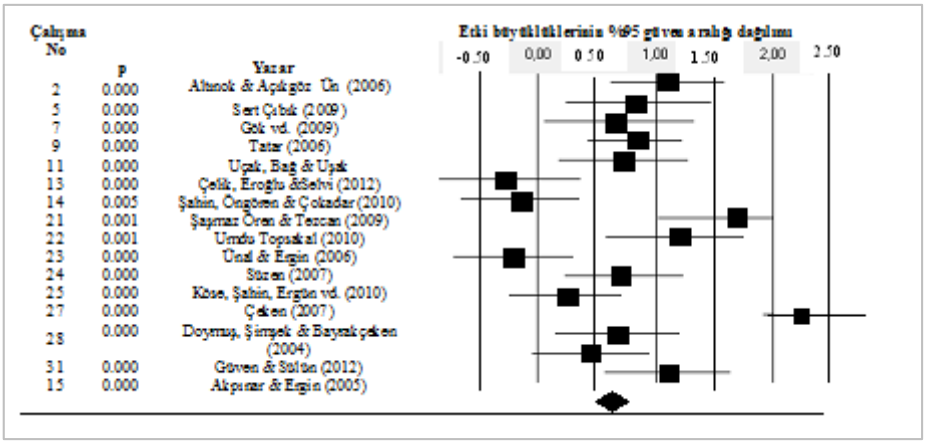
Shape 3. Funnel Plot of Effect Sizes Which Belong to Studies Examining the Attitude Variable

When Shape 3 is examined, effect size distributions of studies examining the attitude variable do not show a symmetrical distribution. Amount of prejudice found by funnel plot has been stated as Begg-Mazumdar Kendall's tau = 0.233 p = 0.207 and Egger: bias = 5.986 (95% CI = -1.240 to 13.213) p=0.0973. Both analysis shows that bias is not significant (Rothstein et al., 2005). It has been found that published studies' effect size is 0.615 and effect size of studies which have not been published is 1.372 from studies included on the attitude variable. It is expected that publishing possibility of studies containing important results as statistical becomes more and, therefore; the average effect size of published studies becomes bigger (Durlak, 1998; Rosenthal, 1991). In this sense, it can be said that there isn't a publishing bias in the study. This shows that effect sizes are suitable for being used to calculate the average effect size.

Fail safe number obtained by the Rosenthal method for this meta-analysis study is 432. According to the Orwin (1983) method, in order that average effect size (EB=0.743) decreases to effect size at small level (EB=0.2) at Cohen's (1988) classification, number of research needing to be included in meta-analysis has been found 43. When fail safe numbers acquired with both methods are looked at, it could be said that this meta-analysis study is reliable.

Effect Sizes' Confidence Intervals Distribution of Studies Examining the Attitude Variable

According to Shape 4 which shows statistical suitability of being combined studies via meta-analysis, as p value of all studies is under 0.05, it could be said that the effect sizes of studies included in meta-analysis and examining the attitude variable are included in confidence intervals. Moreover, that squares (boxes) which represent the importance of the studies and effect sizes are nearly as big as each other expresses consistent studies are combined (Borenstein et al., 2009). That diamond visual representing general effect is narrow shows average whose power and sensibility is high appears.



Shape 4. Confidence Intervals of Studies' Effect Sizes and Their Weights' Diagram Which Examining Attitude Variable

3. Findings Concerning Instructional Applications of Constructivism's Effect on Achievement According to Science Disciplines

Instructional Applications of Constructivism's Effect on Achievement According to Physics Subjects

Data of 10 studies have been combined with the aim of determining instructional applications of constructivism's effect on achievement according to physics subjects. According to the random effects model, it has been calculated as 0.222 standard error and 95% confidence intervals' upper limit 1.460 and lower limit 0.591 with effect size's value ES=1.025 (Wolf, 1986; Hunter & Schmidt, 1990; Rosenthal, 1991; Lipsey & Wilson, 2001). This value has got an large effect according to Cohen (1988) and in large level according to Thalheimer and Cook's (2002) classification. That is to say, when it is thought in terms of physics subjects, instructional applications of constructivism can be said to be largely more effective than traditional ways on the subject of increasing achievement. This result shows consistency with individual study results which research the effect on achievement oriented science and technology lesson of learning-teaching activities on physics subjects (Balım, 2009; Doymuş et al., 2004; Gençosman & Doğru, 2012; Gök et al., 2009; Kıncal, Ergül, & Timur, 2007; Timur & Kıncal, 2010; Ünal & Ergin, 2006).

Instructional Applications of Constructivism's Effect on Achievement According to Chemistry Subjects

Data of eight studies have been combined with the aim of determining instructional applications of constructivism's effect on achievement according to chemistry subjects. According to the random effects model, it is seen as 0.222 standard error and 95% confidence intervals' upper limit 1.522 and lower limit 0.652 with effect size's value ES=1.087 (Hunter & Schmidt, 1990; Lipsey & Wilson, 2001; Rosenthal, 1991; Wolf, 1986). This value has got a large effect according to Cohen (1988) with Thalheimer and Cook's (2002) classification. That is to say, when it is thought in terms of chemistry subjects, instructional applications of constructivism can be said to be largely more effective than traditional ways largely speaking on the whole on the subject of increasing achievement. This result shows consistency with individual study results which research the effect on achievement oriented science and technology lesson of learning-teaching activities on chemistry subjects (Çelik et al., 2012; Güven & Sülün, 2012; Korkmaz & Kaptan, 2002; Süzen, 2007).

Instructional Applications of Constructivism's Effect on Achievement According to Biology Subjects

Data of nine studies have been combined with the aim of determining instructional applications of constructivism's effect on achievement according to biology subjects. According to the random effects model, it has been calculated as 0.135 standard error and 95% confidence intervals ' upper limit 1.157 and lower limit 0.626 with effect size's value ES=0.892 (Hunter & Schmidt, 1990; Lipsey & Wilson, 2001; Rosenthal, 1991; Wolf, 1986). This value has got a large effect according to Cohen (1988) with Thalheimer and Cook's (2002) classification. That is to say, when it is thought in terms of biology subjects, instructional applications of constructivism can be said to be largely more effective than traditional ways largely speaking on the whole on the subject of increasing achievement. This result shows consistency with individual study results which research the effect on achievement oriented science and technology lesson of learning-teaching activities on biology subjects (Akçay et al., 2005; Atay Doğru & Tekkaya, 2008; Aydede & Matyar, 2009; Buzludağ & Yılayaz, 2012; Efe & Bakır, 2006; Tatar & Kuru, 2009; Umdu Topsakal, 2010).

4. Findings Concerning Instructional Applications of Constructivism's Effect on the Attitude Towards Science and Technology Lesson According to Science Disciplines

Instructional Applications of Constructivism's Effect on the Attitude Towards Science and Technology Lesson According to Physics Subjects

Data of six studies have been combined with the aim of determining instructional applications of constructivism's effect on the attitude towards science and technology lesson according to physics subjects. According to the random effects model, it has been found that 0.235 standard error and 95% confidence intervals ' upper limit 0.949 and lower limit 0.030 with effect size's value ES=0.473 (Hunter & Schmidt, 1990; Lipsey & Wilson, 2001; Rosenthal, 1991; Wolf, 1986). This value has got an effect at small level according to Cohen's (1988) classification and at medium level according to Thalheimer and Cook's (2002) classification. That is to say, when it is thought in terms of physics subjects, instructional applications of constructivism can be said to be more effective than traditional ways at small level on the subject of improving positive attitude towards science and technology lesson. This result shows consistency with individual study results which research the effect on attitude oriented science and technology lesson of learning-teaching activities on physics subjects (Altınok & Açıkgöz Ün, 2006; Çıbık Sert, 2009; Doymuş et al., 2004; Gök et al., 2009).

Instructional Applications of Constructivism's Effect on the Attitude Towards Science and Technology Lesson According to Chemistry Subjects

Data of five studies have been combined with the aim of determining instructional applications of constructivism's effect on the attitude towards science and technology lesson according to chemistry subjects. According to the random effects model, it has been calculated as 0.379 standard error and 95% confidence intervals' upper limit 1.587 and lower limit 0.100 with effect size's value ES=0.843 (Hunter & Schmidt, 1990; Lipsey & Wilson, 2001; Rosenthal, 1991; Wolf, 1986). This value has got an effect at medium level according to Cohen's (1988) classification and in large level according to Thalheimer and Cook's (2002) classification. That is to say, when it is thought in terms of

chemistry subjects, instructional applications of constructivism can be said to be more effective than traditional ways on the subject of improving positive attitude towards science and technology lesson . This result shows consistency with individual study results which research the effect on attitude oriented science and technology lesson of learning-teaching activities on chemistry subjects (Uçak et al.,2006; Çelik et al., 2012).

Instructional Applications of Constructivism's Effect on the Attitude Towards Science and Technology Lesson According to Biology Subjects

Data of five studies have been combined with the aim of instructional applications of constructivism's effect on the attitude towards science and technology lesson according to biology subjects. According to the random effects model, it has been calculated as 0.224 standard error and 95% confidence intervals' upper limit 1.408 and lower limit 0.532 with effect size's value ES=0.970 (Hunter & Schmidt, 1990; Lipsey & Wilson, 2001; Rosenthal, 1991; Wolf, 1986). This value has got an large effect according to Cohen (1988) with Thalheimer and Cook's (2002) classification. That is to say, when it is thought in terms of biology subjects, instructional applications of constructivism can be said to be largely more effective than traditional ways on the subject of improving positive attitude towards science and technology lesson. This result shows consistency with individual research results which study the effect on attitude oriented science and technology lesson of learning-teaching activities on biology subjects (Akpınar & Ergin 2005; Şaşmaz Ören & Tezcan, 2009; Tatar & Kuru, 2009).

Discussions, Conclusion and Suggestions

In this meta-analysis study, it has appeared that instructional applications of constructivism are more effective than traditional activities in increasing achievement towards science and technology lesson and improving positive attitude towards science and technology lesson. Besides, it has been found that instructional applications of constructivism are also more effective on the subjects regarding all science disciplines (physics, chemistry, biology) to increase achievement towards science and technology lesson and to improve positive attitude towards science and technology lesson. Below, conclusions and criticisms have been presented in the light of findings about each sub problem:

According to the findings, it has been found that instructional applications of constructivism are largely more effective than traditional ways (ES=1.003) to increase achievement towards science and technology lesson. Instructional applications of constructivism have so many positive effects on learning. For example, subjects, questions and homework are formed in the manner of preventing students' memorizations. It provides an opportunity for students to explain the meaning and questionize the information by using critical thinking abilities. Students are encouraged for using effective learning strategies and they don't learn by sitting in the class and only listening, memorizing information which has been prepared and organized before and giving answers unconsciously. In this way, they can connect information they have just learnt to information they learnt before and apply in daily life (EARGED, 2007). Learning becomes more permanent and significant for students who can associate new information matchlessly and significantly with their previous knowledge via instructional applications of constructivism (McCombs & Whisler, 1997). Learning subjects which are significant for student becomes easier and subjects learnt easily bring academic achievement with them.

Findings mentioned above also match up with the results of PISA and TIMSS. Turkey has been the OECD country which achieves the highest point increase in science achievement when TIMMS 1999 and 2009 results are compared (EURYDICE, 2011; ERG, 2011b; Özenç & Arslanhan, 2010). Furthermore, it was stated in PISA 2012 report that Turkey showed a significant improvement in science achievement (OECD, 2013). On the other hand, even though positive developments are observed in the results of TIMSS and PISA in recent years, it could be said that progress is inadequate when data are examined in detail. According to PISA 2012 results published in 2013 December, it is seen that Turkey is below OECD science achievement average again (OECD, 2013).

When TIMSS 2011 and PISA 2012 results are examined, it is seen that Turkey's achievement increases in assessments which are done in international level but it still cannot reach the desired level. This judgment reached could be commented in the way that while desired achievement can be achieved with instructional applications of constructivism in experimental studies, waited achievement cannot be achieved at schools connected to the Ministry of Education. While waited achievement cannot be attained at elementary schools, there could be so many reasons why achievement level increases significantly in experimental studies: In experimental studies, either the researcher does the practice in experiment group by himself or the researcher gives support to teacher before and during research. Activities and lesson plans are prepared in detail, problems which could appear in practice are tried to be prevented. Stages of educational applications in experimental processes are studied deeply and taken pains to be applied correctly. This process prepared and planned meticulously both motivates the implementer and encourages commitment to work which is done. On the other hand, all equipment necessary for activities are rendered adequate. All these positive effects could enable experimental studies to achieve achievement even in crowded classes.

As known, the general tendency in the world is towards decreasing class sizes. However, although class sizes are quite big in many Asia countries the same as in Turkey, great achievement is seen (Şişman et al., 2011). To correlate class size with achievement will be quite difficult in order that countries have different politics, experiences and reasons for determining class sizes. Nonetheless, when study numbers are examined according to class size and effect size levels in studies included in this meta-analysis study, it has been seen that effect size of instructional applications of constructivism is mostly positive, average and large level on the subject of affecting both the attitude and the achievement in crowded classes (30 persons and more), too. Furthermore, in conditions in which class size is more than 35, it is seen that all effect sizes are positive and large for both two variables (achievement and attitude), too.

It is stated that in many studies that implementation and organization of instructional applications of constructivism and cooperative group activities are quite difficult in crowded classes (Gelbal & Kelecioğlu, 2007; Yapıcı & Demirdelen, 2007). Unquestionably, problems of classroom management will increase and responsibility on teacher will be too much in crowded classes. However, according to findings which Aydede and Matyar (2009) with Süzen (2007) obtained, it is stated that learning-teaching activities based on constructivist approach can be applied and applications in which teachers having enough equipment can be successful in crowded classes, too. When evaluated in terms of Turkey, it could be said that crowded classes will not be an obstacle for instructional applications of constructivism to develop science achievement positively, in the event that enough equipment and implement are found, knowledge and ability levels of teachers become sufficient.

On the other hand, teachers who do not make the right applications of constructivism at schools could also be one of the reasons why desired achievement cannot be reached (Ceylan & Berberoğlu, 2007). Although learning-teaching activities based on constructivist approach are intended in curriculum of science and technology lesson, teaching with activities based on traditional teaching is applied more frequently (Demirbaş, 2008; Serin, 2008; Sözbilir, Şenocak, & Dilber, 2006). This conclusion supports Ceylan and Berberoğlu's (2007) findings, as well. Ceylan and Berberoğlu (2007) who find a negative relationship between instructional applications of constructivism and student achievement in their studies connect this finding to be done teaching with an approach based on traditional activities at schools by the name of constructivism.

While there is officially a science curriculum based on instructional applications of constructivism, there could be many reasons why traditional approach in practice continues. These reasons can be put in order as cultural and regional features, centralized education system, students' academic achievement and learning differences, standardized tests, that instructional applications of constructivism are not understood by teachers and teachers do not know learning-teaching activities

sufficiently or become resistant against change (Balım, 2009; ERG, 2009; EURYDICE, 2011; Ünal, Coştu, & Karataş, 2004; Şişman et al., 2011).

One other reason for not being able to achieve desired achievement level with existing science curriculum based on instructional applications of constructivism could be teachers' knowledge deficiencies directed applying learning-teaching activities. Atila (2012) has concluded that although teachers are aware of the role which curriculum loads themselves, due to the fact that they have deficiencies about understanding based on curriculum and methods-techniques which will be used, they cannot achieve the needs of instructional applications of constructivism. According to a study done by PISA data are used, it has been seen that science teachers in Turkey have deficiencies in the subject of making practical experiments in lessons, connecting subjects in science lesson to daily life, enabling students to determine research subjects, enabling sparring and technology applications (Balım, Deniş, İnel, & Evrekli, 2010). In some studies (e.g., Atila, 2012; Çelik et al., 2012; Yaşar, 2012), it is stated that teachers are willing to apply innovations towards technology and visual materials; however, they still use traditional ways more in lessons.

That teachers do not know their roles in constructivist approach (Çelik Şen & Şahin Taşkın, 2010) is one other reason which is needed to be handled. When constructivism which cannot be comprehend adequately by implementers, put into practice in tradional manner, an inconsistent class climate has been formed.

Teachers who cannot perform counseling position properly complain that instructional applications of constructivism cause an undisciplined class environment (Atila, 2012; Kalender & Berberoğlu, 2009). Nonetheless, in Finland where takes place at upper sorts on the subject of science achievement and science literacy at TIMSS and PISA, some scholars who observe how learning-teaching activities based on constructivist approach are carried out (Simola, 2005 as cited in Çobanoğlu & Kasapoğlu, 2010) deliver an opinion that class applications are quite traditional. Even though this point of view is seen contradictive by some people, in fact, combination of instructional applications of constructivism with pedagogical discipline and order must be indispensable. Eventually, if teachers work to provide student-based class environment in traditional environments, the constructivist approach will not be possible (Atila, 2012; Kalender & Berberoğlu, 2009).

On the other hand, placement test (formerly SBS, TEOG with a new name) which students have to take in Turkey can prevent to be applied in the manner that instructional applications of constructivism are planned. Exam-based education understanding with this national tests influence has become more dominant than philosophical and institutional approaches which take part on the basis of curriculum. That learning-teaching processes come down to the national tests focus prevents teaching which is appropriate for curriculum from being done and affects negatively by restricting learning-teaching processes (MEB, 2010). As a matter of fact, according to Güneş and Baki (2011), some teachers who think students will be unsuccessful in the national exams when lesson is done with instructional applications of constructivism have stated that they have already preferred to do optional test towards exam. Student's parents and manager restraints should also not be disregarded on the subject of teachers preferring exam-based teaching. Students become passive receivers with a learning environment in which teacher centrality comes into prominence, memorizer and competitor.

In some studies carried out on science teaching, it is stated that instructional applications of constructivism are carried out in experiment group while activities belonging to existing curriculum are done in control group (Çetin, 2010; Demirel & Tural, 2010; Evrekli & Balım, 2010; Güçlüer & Kesercioğlu, 2010; Özyılmaz Akamca, 2008; Saygılı, 2010; Şahbaz, 2010; Uzun, 2010). In studies whose application was done after the year 2005, 17 studies which say that traditional teaching is done in control group, but give information that existing curriculum is applied while making explanation related to treatment process elaborately (owing to the fact that curriculum of primary education is based on constructivist approach after 2005, they cannot be accepted as traditional teaching) have not been included in the analysis. In some of mentioned studies, although official curriculum is applied in

control group, it is stated that traditional ways are used according to subjective observations. This expression which is put forward with regard to subjective observations shows the existence of an approach which accepts that traditional ways are put into practice under the name of constructivist curriculum at schools. At this point, an important problem needing to be deal with appears: *Do researchers check the effectiveness of instructional applications of constructivism, or try to prove whether traditional ways are used at schools or not? Do teachers apply curriculum based on instructional applications of constructivism with traditional activities in very deed (officially)?* To be able to answer these two important questions requires learning-teaching process to be scrutinized in a multidimensional manner.

One other result obtained from this meta-analysis study is that instructional applications of constructivism are more effective than traditional ways in average level on the subject of improving positive attitude towards science and technology lesson (95% confidence intervals' upper limit 0.438 and lower limit 1.048 with effect size's value ES=0.743). Instructional applications of constructivism have so many positive effects towards affective domain (Akınoğlu, 2011; Byrne, 1987; McCombs & Whisler, 1997). Effects explained below might support the attitude towards science and technology lesson to improve positively.

Instructional applications of constructivism require students to use top-level strategies for thinking, to check intellectual processes and watch, to become creative and critical. These requirements create positive motivational effect on learning. Self-awareness which is the state that person gathers attention on himself and ego becomes the object of his consciousness, self-control (willpower) and self-belief about his abilities of individual who see what he has learnt and how much he remembers with deep and large information handling process are also affected. Individual becomes more efficient on the subject of defining interests, values and aims of him/herself in this process and self-consciousness for achievement increases. All these things affect feelings and motivation towards learning positively (McCombs & Whisler, 1997). However, in a learning-teaching environment based on constructivist approach, teacher's supporting, warm and relaxed manner increases students' motivation for lesson and provides them to become curious of lesson and interested in subjects. Students feel that their learning and themselves as individuals are cared (Byrne, 1987).

Teacher role and learning responsibility imputed student might also support development of positive attitude towards lesson in classes where learning-teaching activities based on constructivist approach are applied. In these classes, students are not contented with listening what teacher explains or memorizing and repeating memorizations for exam by sitting silently in class. Teacher organizes learning process by way of sharing, guiding and supporting; not by way of teaching. Thus, student achieves learning voluntarily. Common feature of learning-teaching activities used in the process is that they do not dictate, give order, present prepared information; they are based on mutual respect and collaboration, not individualism; they direct to learning, not to fear of failure; they focus on the approach that everybody is valued, not some are appreciated and rewarded (Akınoğlu, 2011; EARGED, 2007). This understanding of teacher supports students who need to feel themselves safe and taste achievement, feel themselves valued, being loved and accepted. Tendencies and inclinations to lesson of students whose sensual needs are satisfied improve positively (EARGED, 2007).

The place of attitude towards that lesson is important for student's achievement in lesson (Özyürek & Eryılmaz, 2001; Schibeci & Riley, 1986; Wilson, 1983). That there is a positive relationship between attitude towards science and technology lesson and achievement has been put forward in some studies (i.e., Dieck, 1997; Martinez, 2002). There are also meta-analysis studies which show that relationship between science achievement and attitude is positive and in high level (i.e., DeBaz, 1994; Weinburgh, 1995). In that respect, it could be said that positive effects on science and technology lesson of instructional applications of constructivism provide lesson achievement to increase. On the other hand, achievement towards science and technology lesson increased by instructional applications of constructivism could also enable attitude towards science and technology lesson to

improve positively. Positive effects on attitude and achievement in science and technology lesson of instructional applications of constructivism show that results which support each other are appeared.

Inferences regarding intervening variables which will be able to affect meta-analysis results obtained towards effect on attitude variable towards science and technology lesson of learning-teaching activities are as follows: That treatment time is enough for attitude to change (Kayıran & İflazoğlu, 2007). In that respect, when effect size levels with regard to treatment time included in meta-analysis are examined, it is seen that effect size for attitude is in average and large level in researches which treatment time is eight weeks and more. In Ellington's (2003) meta-analysis study, it has been found that attitude can be increased positively in studies which learning-teaching activities' treatment time is more than nine weeks. In this respect, treatment time could be thought as an important intervening variable which should be considered to test learning-teaching activities' effect on attitude towards science and technology lesson. As a matter of fact, in examined researches, statements related that treatment time is inadequate for the attitude to change significantly are used at discussing part of studies which significant difference cannot be acquired on attitudes (e.g., Ünal & Ergin, 2006; Şahin et al., 2010; Çetin et al., 2012; Güven & Sülün, 2012).

Numbers of male-female students in experiment and control groups could be another moderator variable which can affect these results. In Weinburgh's (1995) meta-analysis, it has been found that males' attitudes for science are more positive than females. Moreover, attitude for different science disciplines changes according to gender. While males have positive attitude for mostly physics subjects, females have positive attitude for mostly biology (Weinburgh & Englehar, 1994). According to Jones, Howe, and Rua's (2000), males' attitudes for biology subjects and females' attitudes for physics subjects are more negative.

In ROSE (Relevance of Science Education - international research which analyzes students' attitudes and opinions towards science lesson) study, it is suggested that gender differences in interest and motivation should be considered in science teaching (Sjøberg & Schreiner, 2010 as cited in EURYDICE, 2011). When it is looked at in that respect, whether male and female students' numbers are not equal could affect the results in experiment and control groups. In this sense, the studies included in meta-analysis, when that gender distributions are considered or not is examined in experiment and control groups, it is seen that the distributions of students in experiment and control groups according to gender are not given in 19 ones of studies (Akçay et al., 2005; Akpınar & Ergin, 2005; Altınok & Açıkgöz Ün, 2006; Atay Doğru & Tekkaya, 2008; Ayan, 2012; Bozkurt et al., 2008; Çeken, 2007; Çelik et al., 2012; Doymuş et al., 2004; Efe & Bakır 2006; Gençosman & Doğru 2012; Gök et al., 2009; Kıncal et al., 2007; Korkmaz & Kaptan, 2002; Küçükyılmaz, 2003; Şahin et al., 2010; Şaşmaz Ören & Tezcan, 2009; Timur & Kıncal, 2010; Uçak et al., 2006). In three ones of remained 12 studies (Balım, 2009; Buzludağ & Yılayaz, 2012; Ünal & Ergin, 2006), the distribution according to gender is given in the way that male-female number totally, not according to experiment and control groups. In other nine studies, student numbers according to gender for experiment and control groups have been given (Aydede & Matyar, 2009; Balım, Pekmez Şahin, & Özaçık Erdem, 2004; Güven & Sülün, 2012; Köse et al., 2010; Çıbık Sert, 2009; Tatar, 2006; Süzen, 2007; Ulu, 2011; Umdu Topsakal, 2010). It is seen that student numbers according to gender in experiment and control groups are close to each other in three studies (Balım et al., 2004; Çıbık Sert, 2009; Ulu, 2011); and quite different in six studies (Aydede & Matyar, 2009; Güven & Sülün, 2012; Köse et al., 2010; Süzen, 2007; Tatar, 2006; Umdu Topsakal, 2010). In only two studies (Ayan, 2012; Tatar, 2006), statistical analysis has been done to reveal whether student number according to gender affects results or not, and that it does not affect results has been revealed. In all remained studies, any analysis regarding whether student number according to gender affects results or not has not been done and this subject has not been mentioned in discussion part.

In experimental and quasi-experimental studies, whether researcher does the application or not in experiment and control groups and whether different teachers give a lesson could affect students' attitudes for lesson. In the event that the researcher does the application personally, both advantages and disadvantages could appear. Whether researcher has enough class management experience or not and the level of class management skills could affect the results. On the other hand, owing to the fact that researchers carry out the application, to be able to apply learning-teaching activities as they should be will be possible. When studies included in meta-analysis are classified in respect to person who does the application in experiment and control groups, research number which same researcher applies is four and research number which different teachers apply is six in experiment and control group. Research number which the researcher in experiment group and teacher in control group apply is one. Information about that implementer is a researcher or a teacher is not given in 16 ones of studies. Third result acquired from this study is that instructional applications of constructivism in all science disciplines affect achievement of science and technology lesson in large level (in physics subjects, ES=1.025; in chemistry subjects, ES=1.087; in biology subjects, ES=0.923) according to traditional activities. In other words, instructional applications of constructivism increase achievement in all science disciplines. That learning-teaching activities based on constructivist approach support students attendance to process, information is given by being related to previous information towards from known to unknown, from simple to complicated, from concrete to abstract, equipment usage supports effective learning needs at science teaching. All these positive effects mentioned could enable achievement to increase at all science subjects belonging to science disciplines.

Chemistry subjects education is based on laboratory applications carried out through instructional applications of constructivism prevents learning by rote (Özden, 2007). That students learn through equipment, model and sample , which is one of necessary conditions for biology subjects consisting of abstract concepts predominantly to be understood can be provided with instructional applications of constructivism (Saygın, Atılboz, & Salman, 2006; Kaya & Gürbüz, 2002). Thanks to subjects being handled with transdisciplinary approach in instructional applications of constructivism, physics subjects based on especially mathematical formulas and processes can be given by being related with math subjects (Aycan & Yumuşak, 2003; Bahar & Polat, 2007; Kara, Kanlı, & Yağbasan, 2003).

In an effective science teaching, laboratory applications, equipment usage, relating subjects with daily life and students' attendance to the process personally carry weight. In order to learn knowledge, it is necessary to think about that subject, research it deeply, make empirical applications and show subject's relation with other subjects (Akdeniz & Karamustafaoğlu, 2003). Teachers using education strategies which students are active direct them to think more about the world they live and enable them to acquire development skill for these thoughts with knowledge they have just obtained (Smith, Blakeeslee, & Anderson, 1993 as cited in Tatar & Kuru, 2009). These skills simplify the usage of obtained information in daily life (Tatar & Kuru, 2009). However, in classes which are teacher-based, what will be taught is put emphasis on, not how to teach science (Eltinge & Roberts, 1993). Therefore, students can hardly any learn how to use science in their daily life. These differences between science teaching based on traditional activities and science teaching based on instructional applications of constructivism might provide achievement to increase in all science discipline subjects.

Fourth result acquired from this meta-analysis, instructional applications of constructivism are more effective than traditional activities in small level according to Cohen (1988), in average level (ES=0.473) according to Thalheimer and Cook's (2002) classification at physics subjects; in medium level according to Cohen (1988), in large level (ES=0.843) according to Thalheimer and Cook's (2002) classification at chemistry subjects; and in large level (ES=0.970) at biology subjects to develop the attitude towards science and technology lesson positively. In other words, instructional applications of constructivism become more effective than traditional activities to develop attitude positively in all science discipline distributions.

Subjects and notions which will be taught to students are presented verbally by teacher at science teaching which is carried out with traditional activities, then verification experiment is done for verifying presented information. Another application form is to enable all students to watch demonstration experiment which is done by teacher. Procedures which will be done at experiment are explained to students step by step and they are expected to reach the results by following these. Students see science lesson taught in this way boring, real, unconnected with the world (Billings, 2001 as cited in Tatar & Kuru, 2009; Yager, 1991). Therefore, science education carried out with traditional activities could have influence upon students as interest loss, lack of motivation and developing negative attitude towards lesson. On the other hand, that instructional applications of constructivism require students to attend lesson actively and provide opportunities which they generate their knowledge and understanding by themselves and comment their results via constituting hypothesis and designing researches for students to increase their attendance and learning (Roth & Roychoudhury, 1994 as cited in Tatar & Kuru, 2009) could contribute the attitude towards science and technology lesson to develop positively.

When average effect size levels for attitude variable concerning every science disciplines in study are examined, it is seen that while effect size values of chemistry and biology subjects are in large level, effect size value of physics subjects according to Cohen's (2002) classification is small and it has an medium level effect according to Thalheimer and Cook's (2002) classification. According to science disciplines, this difference in effect size value could arise from that students are forced to learn physics subjects more than chemistry and biology subjects (Aksu, 2011; Polat, 2005). According to research which Aksu (2011) did to 6th, 7th and 8th class levels, it is seen that subjects which students comprehend as difficult belong to "Physical Events" learning distribution with 43% pro rata. Lesson subjects which students are forced most: Energy and Transformations, Electrical Current, Electricity Circuits and Electrostatics. These findings are based on the same learning distribution with 51% pro rate in also Polat (2005)'s study. Another reason of this finding could be that students are forced to learn mathematical expressions and calculations which are necessary for physics subjects to be understood (Aycan & Yumuşak, 2003; Bahar & Polat, 2007; Kara et al., 2003). Moreover, opinions which are transferred by way of social interaction among students like "it is difficult to understand physics lesson" could also be effective (White, 1993). Thus, students could approach with prejudice to learn physics subjects.

On the other hand, according to findings, while effect size is found in medium level according to Cohen (1988) and in large level according to Thalheimer and Cook's (2002) classification at chemistry (ES=0.843) subjects, effect size value towards biology (ES=0.970) subjects has emerged in large level. The reason why effect size belonging to biology subjects becomes higher than chemistry subjects could be derived from the fact that students' attitudes towards biology subjects are more positive than physics and chemistry subjects, which is stated in personal studies (Jones et al., 2000; Sungur & Tekkaya, 2003).

According to sub-problems determined in this study, science disciplines have been deal with under physics, chemistry and biology subjects. The fact that science disciplines are examined with different titles could provide valuable contributions to distribution in terms of finding which learning-teaching activity is more effective for each subject. However, that there are not enough studies to acquire these findings is an important deficiency observed. In studies examining achievement variable, it is seen that study has been done on ten studies and mostly physics subjects. Eight studies for chemistry subjects and nine studies for biology subjects have been done. In the event that these studies are deal with in subject level, it is seen that three studies about "What if pressure did not exist?" and one or two studies concerning each subject belonging to other disciplines are done. Same situation is also valid for studies examining attitude variable. There are totally six studies working on attitude variable towards science and technology lesson on physics subject, and five studies on chemistry and biology subjects. Therefore, it is seen that studies on science teaching do not intensify a particular science discipline or a subject. Finally, it is seen that there are not enough study for meta-

analysis with the aim of being able to find which learning-teaching activity is more effective for increasing achievement towards science and technology lesson according to subjects.

Strengths of the examined studies are as follows: In some studies (Akçay et al., 2005; Akpınar & Ergin, 2005; Altınok & Açıkgöz Ün, 2006; Atay Doğru & Tekkaya, 2008; Aydede & Matyar, 2009; Balım et al., 2004; Buzludağ & Yılayaz, 2012; Çeken, 2007; Çelik et al., 2012; Doymuş et al., 2004; Gençosman & Doğru, 2012; Gök et al., 2009; Küçükyılmaz, 2003; Tatar, 2006; Ünal & Ergin, 2006; Balım, 2009; Çıbık Sert, 2009; Timur & Kıncal, 2010; Ulu, 2011; Umdu Topsakal, 2010), it has been seen that the method part is prepared in the manner that it includes all details which reader should be careful. All necessary information like constituting class level experiment and control groups, subject which is worked on, empirical process time, learning-teaching activity's application stages has been explained elaborately. Those negative situations which have been experienced are explained to other scholars and teachers in discussing part of some studies (Ayan, 2012; Gençosman & Doğru, 2012) create a useful information resource for educators who will use related learning-teaching activity. That milestones are given like explaining qualifications teachers should have peculiar to learning-teaching activity whose effectiveness is checked, organizing the environment for learning-teaching activity to be successful, teacher's adequacy related to distribution and preparation of material is another observed original feature in discussing parts of some studies (Doymuş et al., 2004; Tatar, 2006; Timur & Kıncal, 2010; Ulu, 2011). In Balım (2009), Buzludağ and Yılayaz (2012), Çelik et al. (2012), Doymuş et al. (2004), Gençosman and Doğru (2012), Tatar (2006), Ulu's (2011) studies, that situations which teachers should pay attention at class management, activities' application steps, communication or group activities are explained is among yet another distinctive feature.

On the other hand, there are a set of limitations in some studies. In some studies (Ayan, 2012; Bozkurt et al., 2008; Efe & Bakır, 2006; Korkmaz & Kaptan, 2002; Uçak et al., 2006) which find that instructional applications of constructivism are significantly more effective on achievement and attitude towards science and technology lesson than traditional activities, quite superficial information about learning-teaching activity's application steps is given, subjects like features of materials which are used, interaction in class and teacher's qualifications are not mentioned. Learning-teaching process is explained with standard expressions like "Learning environment by doing and living should be created, student's active attendance should be provided". This could be derived from page limit brought for studies which are published in refereed journals. However, each condition which is taken into consideration in application for learning-teaching activity having been proved its effectiveness carries weight in respect to leading the way to teachers who will apply activities. If a learning-teaching activity is increasing achievement towards science and technology lesson in significant level and developing attitude positively, using related activities will augment the value of studies.

Yet another limitation is that suggestions which examined studies bring consist of stereotyped expressions. As is known, that studies bring original suggestions and avoid from explanations qua other studies' repetition are important. Thus, it could be said that field can be contributed and quality of studies will increase. In suggestions part of some studies included in meta-analysis (Balım et al., 2004; Bozkurt et al., 2008; Güven & Sülün, 2012; Kıncal et al., 2007; Küçükyılmaz, 2003; Çıbık Sert, 2009; Timur & Kıncal, 2010), it has been seen that stereotyped expressions repeating themselves from one research to other are used. These expressions are "Interesting and attractor materials should be used, computer should be utilized, teachers should be enabled to get in-service training, collaboration should be made with university, weekly lesson hours should be increased, population should be make broader". Milestone needing to be taken into consideration here is deficiency of creative expressions which will be able to contribute more original to the field and more special to research in suggestion part. Furthermore, in some studies (Atay Doğru & Tekkaya, 2008; Gençosman & Doğru, 2012; Gök et al., 2009; Korkmaz & Kaptan, 2002; Şahin, Öngören & Çokadar, 2012; Uçak et al., 2006; Umdu Topsakal, 2010; Ünal & Ergin, 2006), the suggestion part has never been given place.

Recommendations for implications and future research which can be made are as follows:

1. The instructional applications of constructivism should become widespread in science education in Turkish schools. Below mentioned is the list of things to be done for that purpose:
   a. Teachers should prepare lesson plans based on the constructivism, and they should pay attention to the proper application of teaching techniques.
   b. Science laboratories should be well-equipped with scientific apparatuses, and the need for audio-visual and technological materials should be satisfied.
   c. The traditional classroom layout in rows should be abandoned, and seating arrangements such as horseshoe, circular, and cluster arrangement that facilitate and support interaction and student participation should be preferred.
   d. Teachers should adopt a warm and supportive attitude that makes students feel that they care about students' learning.
2. Teacher handbooks can be produced by collecting lesson plans and materials having been tested their effectiveness and based on instructional applications of constructivism. By being given additional point by Turkish Education Board to publishers preparing course books by taking into consideration these plans and materials, they can be stimulated to benefit from academic studies.
3. Seeing "crowded classes" as an obstacle should be given up in application of learning-teaching activities based on constructivist approach. A curriculum for teachers which will provide professional improvement in classroom management that will facilitate organization of instructional applications of constructivism and is based on association of pedagogic discipline and order with instructional applications of constructivism in crowded classes can be developed.
4. There may be school-centered and long-term professional development programs on the instructional applications of constructivism in physics education, which is likely to increase motivation and facilitate understanding.
5. There should be parent-oriented seminars that are likely to preclude exam-centered education, formed as a result of public pressure.
6. Although instructional applications of constructivism take place in science curriculums published by the MEB (Ministry of National Education), the reasons why student achievement is not in desired level should be investigated, the obstacles related to instructional applications of constructivism coming true should be determined.
7. In this meta-analysis, studies carried out in 5th, 6th, 7th and 8th level have been included. Effectiveness of each learning-teaching activities would be appropriate to be searched by being also included studies carried out in high school and higher education level on science teaching. In this way, evaluation of science teaching would appropriate to be done as both comparatively and completely in all levels in Turkey.
8. Whether there are different variables scrutinizing learning-teaching activities' effects on achievement and attitude towards science and technology lesson or not can be studied. Hence, similar studies can be carried out by changing inclusion criteria.
9. In order to obtain a reliable result in studies of learning-teaching activities' effect on the attitudes, that treatment time is not shorter than eight weeks should be paid attention.

10. Whether learning-teaching activities' effect changes according to "class levels" or not can be investigated by being reached more studies carried out in science teaching by being reduced inclusion criteria.
11. Longitudinal studies testing learning-teaching activities' effect on science achievement and attitudes can be done on learning distributions repeating with convoluted approach from 5th grade till 8th grade every year.
12. Considering findings related to study's physics subject, which learning-teaching activities affect the attitude positively in physics subject can be investigated through meta-analysis of studies testing the effect of learning-teaching activities carried out in different class levels and physics subject on attitudes.
13. According to studies codified as part of this meta-analysis inclusion criteria, it has been determined that there are not any study in units belonging to "Physical Phenomenons" learning area in 6th class level and units belonging to "Living beings and Life" learning area in 5th and 8th class levels. Besides, study has not been carried out on any units belonging to "The world and the Universe" learning area. Studies investigating the learning-teaching activities' effect on achievement and attitudes towards science and technology lesson should be done in units belonging to these learning areas.

References

An asterisk (*) marked with references is indicate studies included in this meta-analysis.

Acar, S. (2011). *Bilgisayar destekli öğretimin öğrencinin fizik kimya biyoloji ve matematik alanlarındaki tutumlarına olan etkisinin meta-analiz yöntemi ile incelenmesi* (Yayımlanmamış yüksek lisans tezi). Yüzüncü Yıl Üniversitesi, Fen Bilimleri Enstitüsü, Van, Türkiye.

Akamca, G. ve Hamurcu, H. (2005). Çoklu zekâ kuramı tabanlı öğretimin öğrencilerin fen başarısı, tutumları ve hatırda tutma üzerindeki etkileri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 28,* 178-187.

*Akçay, S., Aydoğdu, M., Yıldırım, H. İ. ve Şensoy, Ö. (2005). Fen eğitiminde ilköğretim 6. sınıflarda çiçekli bitkiler konusunun öğretiminde bilgisayar destekli öğretimin öğrenci başarısına etkisi. *Kastamonu Eğitim Dergisi, 13*(1), 103-116.

Akdeniz, A. R. ve Karamustafaoğlu, O. (2003). Fizik öğretimi uygulamalarında karşılaşılan güçlükler. *Türk Eğitim Bilimler Dergisi*, *1*(2), 193-202.

Akınoğlu, O. (2011). Öğretim ilke ve yöntemleri. Ş. Tan (Ed.). *Öğretim kuram ve modelleri* içinde (s. 149-202). Ankara: PegemA Akademi.

Akgöz, S., Ercan, İ. ve Kan, İ. (2004). Meta-analizi. *Uludağ Üniversitesi Tıp Fakültesi Dergisi, 30*(2), 107-112.

*Akpınar, E. ve Ergin, Ö. (2005). Yapılandırmacı kurama dayalı fen öğretimine yönelik bir uygulama. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 29,* 9-17.

Aksu, B. (2011). *Fen ve teknoloji öğretmen programında zor olarak algılanan konular ve olası nedenleri öğretmen ve öğrenci görüşleri* (Yayımlanmamış yüksek lisans tezi). Abant İzzet Baysal Üniversitesi, Eğitim Bilimleri Enstitüsü, Bolu, Türkiye.

*Altınok, H. ve Açıkgöz Ün, K. (2006). İşbirlikli ve bireysel kavram haritalamanın fen bilgisi dersine yönelik tutum üzerine etkileri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *30*, 21-28.

Armağan Öner, F. (2011). *Kavramsal değişim metinlerinin etkililiği: meta-analiz çalışması* (Yayımlanmamış doktora tezi). Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara, Türkiye.

*Atay, Doğru, P. ve Tekkaya, C. (2008). Promoting students' learning in genetics with the learning cycle. *The Journal of Experimental Education, 76*(3), 259-280.

Atila, M. E. (2012). *Fen ve teknoloji dersi öğretim programındaki yapılandırmacılığa dayalı öğelerin öğretmenler tarafından algılanışı ve uygulanışı* (Yayımlanmamış doktora tezi). Atatürk Üniversitesi, Eğitim Bilimleri Enstitüsü, Erzurum, Türkiye.

*Ayan, M. (2012). Proje tabanlı öğrenme yaklaşımının ilköğretim öğrencilerinin fen bilgisi dersi akademik başarı düzeyine etkisi. *Türk Eğitim Bilimleri Dergisi*, *10*(1), 167-183.

Ayas, A. P., Çepni, S., Akdeniz, A. R., Özmen, H. , Yiğit, N. ve Ayvacı, H. Ş. (2005). *Kuramdan uygulamaya fen ve teknoloji öğretimi* (3. bs.). Ankara: PegemA Yayıncılık.

Aycan, S. ve Yumuşak, A. (2003). Lise müfredatındaki fizik konularının anlaşılma düzeyleri üzerine bir araştırma. *Milli Eğitim Dergisi*, *159*, 171-180.

*Aydede, M. N. ve Matyar, F. (2009). Aktif öğrenme yaklaşımının fen bilgisi dersindeki akademik başarı ve kalıcılığa etkisi. *Kastamonu Eğitim Dergisi, 17*(1), 137-152.

Aydın, N. ve Yılmaz, A. (2010). Yapılandırıcı yaklaşımın öğrencilerin üst düzey bilişsel becerilerine etkisi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 39*, 57-68.

Aypay, A., Erdoğan, M. ve Sözer, M. A. (2007). Variation among schools on classroom practices in science based on TIMSS–1999 in Turkey. *Journal of Research in Science Teaching, 44*(10), 1417-1435.

Bahar, M. ve Polat, M. (2007). İlköğretim 6-8. sınıflar düzeyindeki fen konularından zor olarak algılananlara yönelik tanılayıcı bir çalışma: Tespitler ve çözüm önerileri. *Kuram ve Uygulamada Eğitim Bilimleri*, *7*(3), 1085-1130.

*Balım, A. G. (2009). The effects of discovery learning on students' success and inquiry learning skills. *Eurasian Journal of Educational Research*, *35*, 1-20.

Balım, A. G., Deniş, H., İnel, D., & Evrekli, E. (2010). Türkiye'deki fen öğretmenleri ne kadar yapılandırmacı?: PISA 2006 sonuçları üzerine bir değerlendirme. *E-Journal of New World Sciences Academy*, *5*(4), 1421-1438.

*Balım, A. G., Pekmez Şahin E. ve Özaçık Erdem, M. (2004). Asitler bazlar konusunda çoklu zekâ kuramına dayalı uygulamaların öğrenci başarısına etkisi. *Ege Eğitim Dergis, 2*(5), 13-19.

Bayraktar, Ş. (2001). A meta-analysis of the effectiveness of computer-assisted instruction in science education. *Journal of Research on Technology in Education*, *34*(2), 173-188.

Bilen, K. ve Aydoğdu, M. (2010). Bitkilerde fotosentez ve solunum kavramlarının öğretiminde tga (tahmin et-gözle-açıkla) stratejisinin kullanımı. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 7*(14), 179-194.

Borenstein, M., Hedges, L. V., Higgins, J. P. T. ve Rothstein, H. R. (2009). *Introduction to meta-analysis.* West Sussex, UK: John Wiley.

*Bozkurt, O., Orhan, A. T., Keskin A. ve Mazi, A. (2008). Fen ve teknoloji dersinde işbirlikli öğrenme yönteminin akademik başarıya etkisi. *Türkiye Sosyal Araştırmalar Dergisi, 2*, 63-78.

*Buzludağ, P. ve Yılayaz, Ö. (2012). 6. Sınıf fen ve teknoloji dersi "canlılarda üreme ve gelişme" ünitesinin işbirlikli öğrenmeyle (Jigsaw tekniği) öğretiminin öğrenci başarısına etkisi. *e-Journal of New World Sciences Academy*, *NWSA-Education Sciences*, *7*(1), 109-117.

Byrne, D. (1987). *Techniques for classroom interaction*. New York: Longman.

Candan, A., Türkmen, L. ve Çardak, O. (2006). Kavram haritalamanın ilköğretim öğrencilerinin hareket ve kuvvet kavramlarını anlamalarına etkileri. *Türk Fen Eğitimi Dergisi*, *1*, 66-75.

Cavanaugh, C. (1998). *The effectiveness of interactive distance education technologies in K-12 learning: A meta-analysis* (Yayımlanmamış doktora tezi). South Florida, USA.

Ceylan, E. (2009). PISA 2006 sonuçlarına göre Türkiye'de fen okuryazarlığında düşük ve yüksek performans gösteren okullar arasındaki farklar. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi*, *6*(2), 55-75.

Ceylan, E. ve Berberoğlu, G. (2007). Öğrencilerin fen başarısını açıklayan etmenler: Bir modelleme çalışması. *Eğitim ve Bilim*, *32*(144), 36-48.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2. bs.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Copas, J., Shi J. Q. (2000). Meta-analysis, funnel plots and sensitivity analysis. *Biostatistics*, *1*, 247-262.

Cumming, G. ve Finch, S. (2005). Inference by eye: Confidence intervals, and how to read pictures of data. *American Psychologist, 60,* 170-180.

*Çeken, R. (2007). *Sekizinci sınıf öğrencilerine fiziksel ve kimyasal değişmelerin basit fen aktiviteleri ile öğretilmesinin başarıya etkisi* (Yayımlanmamış doktora tezi). Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara, Türkiye.

*Çelik, E., Eroğlu, B. ve Selvi, M. (2012). Fen eğitiminde probleme dayalı öğrenme yaklaşımının öğrencilerin akademik başarısı ile fen ve teknoloji dersine yönelik tutumlarına etkisi. *Kastamonu Eğitim Dergisi, 20*(1), *187-202.*

Çelik Şen, Y. ve Şahin Taşkın, Ç. (2010). Yeni ilköğretim programının getirdiği değişiklikler: Sınıf öğretmenlerinin düşünceleri. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi*, *6*(2), 26-51.

Çetin, O. (2010). *Fen ve teknoloji dersinde "çoklu ortam tasarım modeli"ne göre hazırlanmış web tabanlı öğretim içeriğinin öğrenci başarı ve tutumlarına etkisi ile içeriğe yönelik öğretmen ve öğrenci görüşlerinin değerlendirilmesi* (Yayımlanmamış doktora tezi). Dokuz Eylül Üniversitesi, Eğitim Bilimleri Enstitüsü, İzmir, Türkiye.

Çetin, O. ve Günay, Y. (2007). Fen öğretiminde yapılandırmacılık kuramının öğrencilerin başarılarına ve bilgiyi yapılandırmalarına olan etkisi. *Eğitim ve Bilim*, *32*(146), 24-38.

*Çıbık Sert, A. (2009). The effect of the project based learning approach to the attitudes of students towards science lesson. *İlköğretim Online*, *8*(1), 36-47.

Çırakoğlu, M. ve Saracaloğlu, A. S. (2009). İlköğretimin birinci kademesinde çoklu zekâ kuramı uygulamalarının erişiye etkisi. *Türk Eğitim Bilimleri Dergisi*, 7(2), 425-449.

Çobanoğlu, R. ve Kasapoğlu, K. (2010). PISA'da Fin başarısının nedenleri ve nasılları. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *39*, 121-131.

DeBaz, T. P. (1994). A *meta-analysis of the relationship between students' characteristics and achievement and attitudes toward science* (Yayımlanmamış doktora tezi). The Ohio State University, Ohio.

Demirbaş, M. (2008). Altıncı sınıf fen bilgisi ve fen ve teknoloji öğretim programlarının karşılaştırmalı olarak incelenmesi: Öğretim öncesi görüşler. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 21*(2), 313-338.

Demirel, M. ve Turan, B. A. (2010). Probleme dayalı öğrenmenin başarıya, tutuma, bilişötesi farkındalık ve güdü düzeyine etkisi. H*acettepe Üniversitesi Eğitim Fakültesi Dergisi, 38*, 55-66.

Demirel, Ö., Şahan, H. H., Ekinci, N., Özbay, A. ve Begimgil, A. M. (2006). Basamaklı öğretim programının süreç ve ürün açısından değerlendirilmesi. *Milli Eğitim Dergisi, 172*, 72-90.

Demirci, C. (2010). Cooperative learning approach to teaching science. *Eğitim Araştırmaları Dergisi*, *40*, 36-52.

Demirci, N. ve Çınkı, A. (2009). V-diyagramları kullanımının ilköğretim 6. sınıf öğrencilerinin fen deneylerindeki başarılarına etkisi. O*ndokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi*, *28*, 23-36.

Dieck, A. P. (1997). *An effect of a newsletter on children's interest in an attitude toward science* (Yayımlanmamış yüksek lisans tezi). Arizona State University, ABD.

Doymuş, K., Aksoy, G., Daşdemir, İ., Şimşek, Ü. ve Karaçöp, A. (2006). Fen bilgisi laboratuvarı uygulamalarında işbirlikli öğrenme yönteminin kullanılması. *Kazım Karabekir Eğitim Fakültesi Dergisi, 13*, 157-166.

*Doymuş, K., Şimşek, Ü. ve Bayrakçeken, S. (2004). İşbirlikçi öğrenme yönteminin fen bilgisi dersinde akademik başarı ve tutuma etkisi. *Türk Fen Eğitimi Dergisi*, *1*(2), 103-115.

Durlak, J. A. (1998). Understanding meta-analysis. L. G. Grimm ve P. R. Yarnold (Ed.). *Reading and understanding multivaiate statistics* içinde (s. 319-352). Washington DC: American Psychological Association.

EARGED. (2007). *Öğrenci merkezli eğitim uygulama modeli*. Ankara: Milli Eğitim Basımevi.

EARGED. (2003). *TIMSS 1999 üçüncü uluslararası matematik ve fen bilgisi çalışması ulusal rapor*. Ankara: Milli Eğitim Basımevi.

*Efe, N. ve Bakır, S. (2006). İlköğretim 8. sınıfta üreme konusunun bilgisayar destekli öğretiminin öğrenci başarısına etkisi. *Kazım Karabekir Eğitim Fakültesi Dergisi, 13*, 271-284.

Ellington, A. J. (2003). A meta-analysis of the effects of calculators on students' achievement and attitude levels in precollege mathematics classes. *Journal for Research in Mathematics Education*, *34*(5), 433-463.

Eltinge, M. E. ve Roberts, W. C. (1993). Linguistic contet analysis: A method to measure science as inquiry in textbooks. *Journal of Research in Science Teaching*, *30*(1), 65-83.

ERG. (2011a). *Türkiye'de matematik ve fen bilimleri alanlarında öğrenci performansı ve başarının belirleyicileri, TIMSS 2011 analizi*. http://erg.sabanciuniv.edu/sites/erg.sabanciuniv.edu/files/ERG%20TIMSS%202011%20Analizi%20Rapor.pdf adresinden erişildi.

ERG. (2011b). *Herkes için kaliteli eğitim*. http://erg.sabanciuniv.edu/sites/erg.sabanciuniv.edu/files/EIR2010izleme%20raporu.pdf adresinden erişildi.

EURYDICE. (2011). *Avrupa'da fen eğitimi: Ulusal politikalar, uygulamalar ve araştırma*. http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/133TR.pdf adresinden erişildi.

Evrekli, E. ve Balım, G. A. (2010). Fen ve teknoloji öğretiminde zihin haritası ve kavram karikatürü kullanımının öğrencilerin akademik başarılarına ve sorgulayıcı öğrenme becerileri algılarına etkisi. *Batı Anadolu Eğitim Bilimleri Dergisi*, *1*(2), 76-98.

Freedman, M. P. (1997). Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge. *Journal of Research in Science Teaching, 34*(4), 231-243.

Gelbal, S. ve Kelecioğlu, H. (2007). Öğretmenlerin ölçme değerlendirme yöntemleri hakkındaki yeterlik algıları ve karşılaştıkları sorunlar. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 33*, 135-145.

*Gençosman, T. ve Doğru, M. (2012). Effect of student teams-achievement divisions technique used in science and technology education on self-efficacy, test anxiety and academic achievement. *Journal of Baltic Science Education, 11*(1), 43-54.

Geraedts, C., Boersma, K. T. ve Eijkelhof, H. M. (2006). Towards coherent science and technology education. *Journal of Curriculum Studies*, *38*(3), 307-325.

Glass, G. V. (1976). Primary, secondary and meta-analysis of research. *American Educational Research Association*, *5*(10), 3-8.

*Gök, Ö., Doğan, A., Doymuş, K. ve Karaçöp, A. (2009). İşbirlikli öğrenme yönteminin ilköğretim öğrencilerinin akademik başarılarına ve fene olan tutumlarına etkileri. *Gazi Eğitim Fakültesi Dergisi*, *29*(1), 193-209.

Güçlüer, E. ve Kesercioğlu, T. (2010). Fen ve teknoloji dersinde fen okuryazarlığına yönelik etkinliklerin kullanılmasının öğrenci başarısına etkisi. *e-Journal of New World Sciences Academy Education Sciences, 5*(2), 446-455.

Güneş, B. ve Baki, A. (2011). Dördüncü sınıf matematik dersi öğretim programının uygulanmasından yansımalar. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 41*, 192-205.

*Güven, G. ve Sülün, Y. (2012). Bilgisayar destekli öğretimin 8.sınıf fen ve teknoloji dersindeki akademik başarıya ve öğrencilerin derse karşı tutumlarına etkisi. *Türk Fen Eğitimi Dergisi, 9*(1), 68-79.

Güven, İ. (2009). *Türkiye ile Kanada fen eğitiminin karşılaştırılması ve önerilen bir fen uygulaması* (Yayımlanmamış doktora tezi). Marmara Üniversitesi, Eğitim Bilimleri Enstitüsü, İstanbul, Türkiye.

Hedges, L. ve Olkin, I. (1986). Meta analysis: A review and a new view. *American Educational Research Association,* 15*(8),* 14-16.

Hunter, J. E. ve Schmidth, F. (1990). *Methods of meta-analysis*. Newbury Park, CA: Sage Publications.

Johnson, D. W., Johnson, R. T. ve Stanne, M. B. (2000). *Cooperative learning methods: A meta-analysis.* http://www.tablelearning.com/uploads/File/EXHIBIT-B.pdf adresinden erişildi.

Jones, G. M., Howe, A. ve Rua, M. (2000). Gender differences in students'experinces, interests, and attitudes toward science and scientist. *Science Education, 84*(1), 180-192.

Kablan, Z., Topan, B. ve Erkan, B. (2013). Sınıf içi öğretimde materyal kullanımının etkililik düzeyi: Bir meta-analiz çalışması. *Kuram ve Uygulamada Eğitim Bilimleri Dergisi*, *13*(3), 1629-1644.

Kalender, İ. ve Berberoğlu, G. (2009). An assessment of factors related to science achievement of Turkish students. *International Journal of Science Education, 31*(10), 1379-1394.

Kara, M., Kanlı, U. ve Yağbasan, R. (2003). Lise 3. sınıf öğrencilerinin ışık ve optik ile ilgili anlamakta güçlük çektikleri kavramların tespiti ve sebepleri. *Milli Eğitim Dergisi*, *158*, 221-232.

Karamustafaoğlu, O. (2009). Fen ve teknoloji eğitiminde temel yönelimler. *Kastamonu Eğitim Dergisi, 17*(1), 87-102.

Kaşarcı, İ. (2013). *Proje tabanlı öğrenme yaklaşımının öğrencilerin akademik başarı ve tutumlarına etkisi: Bir meta-analiz çalışması* (Yayımlanmamış yüksek lisans tezi). Osmangazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Eskişehir, Türkiye.

Kaya, E. ve Gürbüz, H. (2002). Lise ve meslek lisesi öğrencilerinin biyoloji öğretiminin sorunlarına ilişkin görüşleri. *Erzincan Eğitim Fakültesi Dergisi*, *4*(2), 11-21.

Kayıran, B. K. ve İflazoğlu, A. (2007). Çoklu zekâ kuramı destekli kubaşık öğrenme yönteminin Türkçe dersine ilişkin tutuma ve okuduğunu anlama başarısına etkisi. *Eurasian Journal of Educational Research*, *29*, 129-141.

Keleş, U. P. (2009). *Kavramsal değişim metinleri, oyun ve drama ile zenginleştirilmiş 5E modelinin etkililiğinin belirlenmesi: "Canlıları sınıflandıralım" örneği* (Yayımlanmamış doktora tezi). Karadeniz Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Trabzon, Türkiye.

*Kıncal, R., Ergül, E. ve Timur, S. (2007). Fen bilgisi öğretiminde işbirlikli öğrenme yönteminin öğrenci başarısına etkisi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 32*, 56-163.

*Korkmaz, H. ve Kaptan, F. (2002). Fen eğitiminde proje tabanlı öğrenme yaklaşımının ilköğretim öğrencilerinin akademik başarı, akademik benlik kavramı ve çalışma sürelerine etkisi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 22*, 91-97.

*Köse, S., Şahin, A., Ergün, A. ve Gezer, K. (2010). The effects of cooperative learning experience on eighth grade students' achievement and attitude toward science. *Eğitim Dergisi*, *131*(1), 169-180.

Kulik, C., Schwalb, B. J. ve Kulik, J. (1982). Programmed instruction in secondary education: A meta-analysis of evaluation findings. *The Journal of Educational Research*, *75*(3), 133-138.

*Küçükyılmaz, E. A. (2003). *Fen bilgisi dersinde öğrenme halkası yaklaşımının öğrencilerin akademik başarılarına ve hatırlama düzeylerine etkisi* (Yayımlanmamış doktora tezi). Anadolu Üniversitesi, Eğitim Bilimleri Enstitüsü, Eskişehir, Türkiye.

Lipsey, M. W. ve Wilson, D. B. (2001). *Practical meta-analysis*. Beverly Hills, CA: Sage Publications.

Long, J. (2001). *An introduction to and generalization of the "Fail-Safe N"*. ERIC veritabanından erişildi (ED449210).

Martinez, A. (2002). Student achievement in science: A longitudinal look at individual and school differences. http://wwwlib.umi.com/dissertations/fullcit/3055869 adresinden erişildi.

Marzano, R. J., Pickering, D. J. ve Pollock, J. E. (2001). Classroom instruction that works: Research-based strategies for increasing student achievement. *Öğrenci başarısını artıran öğretim stratejileri* (S. Şakacı, Çev.). İstanbul: SEV Matbaacılık ve Yayıncılık.

MEB. (2010). Seviye belirleme sınavının değerlendirilmesi. http://www.meb.gov.tr/earged/earged/sbs_deger.pdf adresinden erişildi.

MEB. (2006). *İlköğretim 6-7-8 sınıf fen ve teknoloji programı*. Ankara: Talim ve Terbiye Kurulu Başkanlığı.

MEB. (2004). *İlköğretim fen ve teknoloji dersi (4-5. sınıflar) öğretim programı.* Ankara: Talim ve Terbiye Kurulu Başkanlığı.

McCombs, B. L. ve Whisler, J. S. (1997). *The learner centered classroom and school.* San Francisco: Jossey Bass Publishers.

Murphy, K. R. ve Myors, B. (2004). *Statistical power analysis: A simple and general model for traditional and modern hypothesis tests* (2. bs.). USA: Laurance Erlbaum Associates, Inc.

OECD. (2013). Education policy outlook: Turkey. http://www.oecd.org/edu/EDUCATION%20POLICY%20OUTLOOK%20TURKEY_EN.pdf adresinden erişildi.

Oruç, M. (1993). *İlköğretim okulu II. kademe öğrencilerinin fen tutumları ile fen başarıları arasındaki ilişki* (Unpublished master's thesis). Hacettepe University, Graduate School of Natural and Applied Sciences, Ankara, Turkey.

Orwin, R. G. (1983). A fail-safe N for effect size in meta-analysis. *Journal of Educational Statistics*, *8*, 157-159.

*Ören, F. Ş. ve Tezcan, R. (2009). İlköğretim 7. sınıf fen bilgisi dersinde öğrenme halkası yaklaşımının öğrencilerin tutumları üzerine etkisi. *İlköğretim Online*, *8*(1), 103-118.

Özden, M. (2007). Kimya öğretmenlerinin kimya öğretiminde karşılaştıkları sorunların nitel ve nicel yönden değerlendirilmesi: Adıyaman ve Malatya illeri örneği. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 22*(2), 40-53.

Özenç, B. ve Arslanhan, S. (2010). PISA 2009 sonuçlarına ilişkin bir değerlendirme. http://www.tepav.org.tr/upload/files/1292255907-8.PISA_2009_Sonuclarina_Iliskin_Bir_Degerlendirme.pdf adresinden erişildi.

Özsevgeç, T. (2006). Kuvvet ve hareket ünitesine yönelik 5E modeline göre geliştirilen öğrenci rehber materyalinin etkililiğinin değerlendirilmesi. *Türk Fen Eğitimi Dergisi, 2*, 36-48.

Özsoy, S. ve Özsoy, G. (2013). Eğitim araştırmalarında etki büyüklüğü raporlanması. *İlköğretim Online, 12,* 334-346.

Özyılmaz Akamca, G. (2008). *İlköğretimde analojiler, kavram karikatürleri ve tahmin-gözlem-açıklama teknikleriyle desteklenmiş fen ve teknoloji eğitiminin öğrenme ürünlerine etkisi* (Yayımlanmamış doktora tezi). Dokuz Eylül Üniversitesi, Eğitim Bilimleri Enstitüsü, İzmir, Türkiye.

Özyürek, A. ve Eryılmaz, A. (2001). Öğrencilerin fizik derslerine yönelik tutumlarını etkileyen etmenler. *Eğitim ve Bilim*, *26*(120), 21-28.

Polat, M. (2005). *İlköğretim ikinci kademe fen bilgisi derslerinde ki zor olan konuların tespiti, zorluk sebepleri ve çözüm önerileri* (Yayımlanmamış yüksek lisans tezi). Abant İzzet Baysal Üniversitesi, Sosyal Bilimler Enstitüsü, Bolu, Türkiye.

Rosenthal, R. (1991). *Meta- analytic procedures for social research*. Beverly Hills, CA: Sage Publications.

Roth, W. M. ve Roychoudhury, A. (1992). The social construction of scientific concepts or the concept map as constription devicea and tool for social thinking in high school science. *Science Education*, *76*(5), 531-557.

Rothstein, H. R., Sutton, A. J. ve Borenstein, M. (Ed.). (2005). *Publication bias in meta-analysis: Prevention, assessment and adjustments*. John Wiley & Sons.

Saygılı, G. (2010). *Öğretim teknolojilerinin fen ve teknoloji dersinde kullanımının ilköğretim öğrencilerinin problem çözme becerilerine öğrenme ve ders çalışma stratejilerine üst düzey düşünme becerilerine fen ve teknoloji dersine yönelik tutumlarına ve ders başarısına etkisinin incelenmesi* (Yayımlanmamış doktora tezi). Dokuz Eylül Üniversitesi, Eğitim Bilimleri Enstitüsü, İzmir, Türkiye.

Saygın, Ö., Atılboz, N. G. ve Salman, S. (2006). Yapılandırmacı öğretim yaklaşımının biyoloji dersi konularını öğrenme başarısı üzerine etkisi: canlılığın temel birimi-hücre. *GÜ, Gazi Eğitim Fakültesi Dergisi*, *26*(1), 51-64.

Serin, G. (2009). *Probleme dayalı öğrenme öğretiminin 7. sınıf öğrencilerin fen başarısına, fene karşı tutumuna ve bilimsel süreç becerilerine etkisi* (Yayımlanmamış doktora tezi). Orta Doğu Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Ankara, Türkiye.

Serin, U. (2008). *İzmir ilinde görev yapan fen alanı öğretmenlerinin öğretme strateji ve stilleri ile tercih ettikleri öğretim yöntemleri ve çoklu zekâ alanları arasındaki ilişki* (Yayımlanmamış doktora tezi). Dokuz Eylül Üniversitesi, Eğitim Bilimleri Enstitüsü, İzmir.

Serin, O. ve Mohammadzadeh, B. (2008). The relationship between primary school students' attitudes towards science and their science achievement (sampling: İzmir). *Cypriot Journal of Educational Sciences*, *3*(2), 68-75.

Schibeci, R. A. ve Riley, J. P. (1986). Influence of students' background and perceptions on science attitudes and achievement. *Journal of Research in Science Teaching, 23*, 177-187.

Smith, D. (1996). *A meta analysis of student outcomes attributable to the teaching of science as inquiry as compared to traditional methodology* (Unpublished doctoral dissertation). Temple University, US.

Sözbilir, M., Şenocak, E., & Dilber, R. (2006). Öğrenci gözüyle fen bilgisi öğretmenlerinin derslerinde kullandıkları öğretim yöntem ve teknikleri. *Milli Eğitim Dergisi*, *172*, 276-286.

Spiegel, M. R. (1961). *Theory and problems of statistics*. New York: Schaum Publishing.

Sungur, S., & Tekkaya, C. (2003). Students' achievement in human circulatory system unit: the effect of reasoning ability and gender. *Journal of Science Education and Technology*, *12*, 59-64.

*Süzen, S. (2007). *Aktif öğrenme teknikleriyle desteklenmiş fen ve teknoloji eğitiminin öğrenme ürünlerine etkisi* (Yayımlanmamış doktora tezi). Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara, Türkiye.

Şahbaz, Ö. (2010). *İlköğretim 5. sınıf fen ve teknoloji dersinde kullanılan farklı yöntemlerin öğrencilerin bilimsel süreç becerileri, problem çözme becerileri, akademik başarıları ve hatırda tutma üzerindeki etkileri* (Yayımlanmamış doktora tezi). Dokuz Eylül Üniversitesi, Eğitim Bilimleri Enstitüsü, İzmir, Türkiye.

Şaşmaz Ören, F. ve Tezcan, R. (2009). İlköğretim 7. sınıf fen bilgisi dersinde öğrenme halkasının öğrencilerin tutumları üzerine etkisi. *İlköğretim Online*, *8*(1), 103-118.

*Şahin, A., Öngören, H. ve Çokadar, H. (2010). Çoklu zekâ kuramı tabanlı öğretimin öğrencilerin fen bilgisine yönelik tutumlarına etkisi. e-*Journal of New World Sciences Academy*, *5*(2), 431-445.

Şişman, M., Acat, M. B., Aypay, A. ve Karadağ, E. (2011). *TIMSS 2007 uluslararası matematik ve fen eğilimleri araştırması ulusal matematik ve fen raporu 8. sınıflar*. Ankara: Vaktaş Okul Donatım Basın Yayın.

Tarım (2003). *Kubaşık öğrenme yönteminin matematik öğretimindeki etkinliği ve kubaşık öğrenme yöntemine ilişkin bir meta-analiz çalışması* (Yayımlanmamış doktora tezi). Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Adana, Türkiye.

Tatar, N. ve Kuru, M. (2009). Açıklamalı yöntemlere karşı araştırmaya dayalı öğrenme yaklaşımı: ilköğretim öğrencilerinin fen bilgisi dersine yönelik tutumlarına etkileri. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *25*(1), 142-152.

*Tatar, N. (2006). *İlköğretim fen eğitiminde araştırmaya dayalı öğrenme yaklaşımının bilimsel süreç becerilerine, akademik başarıya ve tutuma etkisi* (Yayımlanmamış doktora tezi). Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara, Türkiye.

Thalheimer, W. ve Cook, S. (2002). *How to calculate effect size from published research: A simplified spreadsheet*. http://www.bwgriffin.com/gsu/courses/edur9131/content/Effect_Sizes_pdf5.pdf adresinden erişildi.

Timur, B. ve Kıncal, R. (2010). İlköğretim 7. sınıf fen bilgisi dersinde sorgulamalı öğretimin öğrenci başarısına etkisi. *Türk Eğitim Bilimleri Dergisi*, *8*(1), 41-65.

Tok, Ş. (2008). Not tutma ve bil-iste-öğren (biö) stratejilerinin tutum ve akademik başarıya etkisi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *34*, 244-253.

Turhan, F., Aydoğdu, M., Şensoy, Ö. ve Yıldırım, H. İ. (2008). İlköğretim 8. sınıf öğrencilerinin bilişsel gelişim düzeyleri, fen bilgisi başarıları, fen bilgisine karşı tutumları ve cinsiyet değişkenleri arasındaki ilişkinin incelenmesi. *Kastamonu Eğitim Dergisi*, *16*(2), 439-450.

*Uçak, E., Bağ, H. ve Uşak, M. (2006). Enhancing learning through multiple intelligences in elementary science education. *Journal of Baltic Science Education, 2*(10), 61-69.

*Ulu, C. (2011). *Fen öğretiminde araştırma sorgulamaya dayalı bilim yazma aracı kullanımının kavramsal anlama, bilimsel süreç ve üstbiliş becerilerine etkisi* (Yayımlanmamış doktora tezi). Marmara Üniversitesi, Eğitim Bilimleri Enstitüsü, İstanbul, Türkiye.

*Umdu Topsakal, Ü. (2010). 8. sınıf 'canlılar için madde ve enerji' ünitesi öğretiminde işbirlikli öğrenme yönteminin öğrenci başarısına ve tutumuna etkisi. *Ahi Evran Üniversitesi Eğitim Fakültesi Dergisi*, *11*(1), 91-104.

Ural, M. N. (2009). *Eğitsel bilgisayar oyunlarının eğlendirici ve motive edici özelliklerinin akademik başarıya ve motivasyona etkisi* (Yayımlanmamış doktora tezi). Anadolu Üniversitesi, Eğitim Bilimleri Enstitüsü, Eskişehir, Türkiye.

Uzun, B. (2010). *Fen ve teknoloji öğretiminde kavramsal değişim stratejilerine dayalı olarak maddenin yapısı ve özellikleri konusunun öğretimi* (Yayımlanmamış doktora tezi). Dokuz Eylül Üniversitesi, Eğitim Bilimleri Enstitüsü, İzmir, Türkiye.

*Ünal, G. ve Ergin, Ö. (2006). Buluş yoluyla fen öğretiminin öğrencilerin akademik başarılarına, öğrenme yaklaşımlarına ve tutumlarına etkisi. *Türk Fen Eğitimi Dergisi*, *3*(1), 37-52.

Ünal, S., Coştu, B., & Karataş, F.Ö. (2004). Türkiye'de fen bilimleri eğitimi alanındaki çalışmalar genel bir bakış. *Gazi Eğitim Fakültesi Dergisi*, *14*(2), 183-202.

Weinburgh, M. (1995). Gender differences in student attitudes toward science: A meta-analysis 18 of the literature from 1970 to 1991. *Journal of Research in Science Teaching, 32*, 387-398.

Weinburgh, M. H. ve Englehar, G., Jr. (1994). Gender, prior academic performance and beliefs as predictors of attitudes toward biology laboratory experiences. *School Science and Mathematics, 94*, 118-123.

White, R. T. (1993). *Learning science* (4. bs.). Oxford: Blackwell Publishers.

Wilson, V. (1983). A meta-analysis of the relationship between science achievement and science attitude: Kindergarten through college. *Journal of Research in Science Teaching*, *20*(9), 839-850.

Wolf, F. M. (1986). *Meta-analysis quantitative methods for research synthesis*. Beverly Hills, CA: Sage Publications.

Yager, E. R. (1991). The constructivist learning model: Towards real reform in science education. *The Science Teacher*, *58*(6), 52-57.

Yapıcı, M. ve Demirdelen, C. (2007). İlköğretim 4. sınıf sosyal bilgiler öğretim programına ilişkin öğretmen görüşleri. *İlköğretim Online, 6*(2), 204-212.

Yaşar, M. D. (2012). *9. Sınıf kimya öğretim programındaki yapılandırmacılığa dayalı öğelerin öğretmenler tarafından algılanışı ve uygulamasına yönelik bir inceleme: Erzurum örneği* (Doktora tezi). Atatürk Üniversitesi, Eğitim Bilimleri Enstitüsü, Erzurum, Türkiye.

Yılmaz H. ve Huyugüzel Çavaş P. (2006). 4-E öğrenme döngüsü yönteminin öğrencilerin elektrik konusunu anlamalarına olan etkisi. *Türk Fen Eğitimi Dergisi*, *3*(1), 2-18.

Zhou, M. (1995). *Meta-analysis of effect of the laboratory component of secondary school science instruction on student learning* (Yayımlanmamış doktora tezi). Temple Universty, America.