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# A Meta-Analysis of the Effect of Contemporary Learning Approaches on Students' Mathematics Achievement*

# Çağdaş Öğrenme Yaklaşımlarının Matematik Dersi Akademik Başarısına Etkisi Üzerine Bir Meta Analiz Çalışması

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**ABSTRACT**: The purpose of this research is to synthesize the results of experimental studies which investigated the effect of certain contemporary learning approaches including cooperative learning, multiple intelligence-based learning, problem-based learning, and constructivist learning approach on students' mathematics achievement via meta-analysis method. In order to collect the data, first the inclusion criteria were determined and a coding form was developed. As a result, the meta-analysis involved 47 experimental studies published between 2005 and 2014, which investigated the impact of contemporary learning approaches on learners' mathematics achievement. Based on the findings obtained from 2627 subjects who took part in these studies, a synthesis was done about the impact of contemporary learning approaches on mathematics achievement. The analysis based on the random effects model revealed that using contemporary learning approaches have a significant ($p< 0.001$) impact on mathematics achievement with a large effect size ($d=0.93$). *This finding suggests that using contemporary learning approaches in mathematics lessons is effective in increasing the learners' mathematics achievement*. As a result of the comparisons of common effect sizes between the groups based on random effects model, no statistically significant difference was observed between the specific learning approaches ($Q_{BG}=6.456$, $df=3$, $p= .091$) and the school stages ($Q_{BG}=4.136$, $df=2$, $p=.126$). Moreover, the meta-regression analysis based on random effects model revealed no statistically significant effect of the duration of treatment on learners' mathematics achievement in the lessons conducted in accordance with the contemporary learning approaches ($z=-0.04990$, $p> .05$). However, it was found that group size had a significant negative effect on mathematics achievement in the lessons conducted in accordance with the contemporary learning approaches ($z=-2.12076$, $p< .05$), i.e. *as the number of students decreases, the better results are achieved from contemporary learning approaches in terms of learners' math achievement.*

**Keywords:** Contemporary learning approaches, traditional approach, meta-analysis, mathematics achievement

**ÖZ:** Bu araştırmada çağdaş öğrenme yaklaşımları kapsamında değerlendirilen işbirlikli öğrenme, çoklu zekâ kuramına dayalı öğrenme, probleme dayalı öğrenme ve yapılandırmacı öğrenme yaklaşımlarının matematik dersi akademik başarısına etkisinin incelendiği deneysel çalışmalardan elde edilen sonuçların meta-analiz yoluyla sentezlenmesi amaçlanmıştır. Verilerin toplanması için dâhil edilme kriterleri belirlenip kodlama formu hazırlanmıştır. Bu doğrultuda çağdaş öğrenme yaklaşımlarının matematik başarısına etkisini inceleyen ve 2005–2014 yılları arasında yayınlanmış toplam 47 deneysel çalışma meta-analize dâhil edilmiştir. Bu araştırmalara katılan 2627 denekten elde edilen bulgulara göre çağdaş öğrenme yaklaşımlarının matematik başarısına etkisine ilişkin sentezlemeye gidilmiştir. Rastgele etkiler modeline göre yapılan analizler sonucunda çağdaş öğrenme yaklaşımların matematik başarısı üzerindeki etkisinin anlamlı ($p<0.001$) ve geniş ($d=0.93$) olduğu saptanmıştır. Bu değer çağdaş öğrenme yaklaşımlarının öğrencilerin matematik başarısını artırmada anlamlı düzeyde daha etkili olduğunu göstermektedir. Rastgele etkiler modeline göre yapılan analizler sonucunda çalışmaların ortak etki büyüklükleri açısından yapılan gruplar arası karşılaştırmalarda, uygulanan yaklaşımlar arasında ($Q_{GA}=6.456$, $sd=3$, $p=.091$) ve deneyin yapıldığı öğretim kademeleri arasında ($Q_{GA}=4.136$, $sd=2$, $p=.126$) istatistiksel açıdan anlamlı bir fark olmadığı görülmüştür. Ayrıca rastgele etkiler modeline göre yapılan meta-regresyon analizi sonucunda çağdaş öğrenme yaklaşımlarına dayalı yürütülen deneysel çalışmalarda deney süresinin matematik başarıları açısından anlamlı bir etkiye sahip olmadığı ($z=-0.0499$, $p>.05$) görülmüştür. Ancak grup büyüklüğünün çağdaş öğrenme yaklaşımlarına dayalı yürütülen deneylerde öğrencilerin matematik başarılarına anlamlı bir etkisinin olduğu ($z=-2.12076$, $p<.05$) ortaya çıkmıştır. Buna göre sınıftaki öğrenci sayısı

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azaldıkça, çağdaş öğrenme yaklaşımlarını kullanmanın öğrencinin matematik başarısı üzerindeki etkisi de olumlu yönde artmaktadır.

**Anahtar sözcükler:** Çağdaş öğrenme yaklaşımları, geleneksel yaklaşım, meta analizi, matematik başarısı

## 1. INTRODUCTION

To adapt to the contemporary world it is an obligation for education systems to reform their goals and procedures in line with the needs of changing society (Genç & Eryaman, 2013). As a result of this obligation, Ministry of National Education launched comprehensive renewal efforts in 2004 to promote a pedagogical approach to make learners more active both mentally and physically. One of the renewed curricula in this respect was that of mathematics. Began to be implemented in 2005, the renewed mathematics curriculum included directions to use teaching strategies, methods, and techniques that make learners active mentally and physically, activities that help students learn by exploring and comprehending, and content that is associated with learners' real lives (MEB, 2009).

With the advent of renewed curriculum, contemporary learning approaches (e.g. multiple intelligence theory, cooperative learning, problem-based learning, constructivism etc.) have been emphasized more than traditional teaching approaches. These learning approaches advocate that learners should be at the centre of teaching process and teaching-learning process is organized so as to enable the learners to learn in cooperation with their classmates by means of their differentiated learning methods, skills, interests and pre-existing experiences (Titiz, 2005).

First developed by Howard Gardner, multiple intelligence theory is one of the most popular contemporary learning approaches which highlight the importance of individual differences in education (Bümen, 2005; Şad & Arıbaş, 2008). According to this theory learners have eight intelligence profiles. They are verbal-linguistic, logical-mathematical, bodily-kinaesthetic, visual-spatial, musical-rhythmic, interpersonal, intrapersonal, and naturalistic intelligences. Mathematics education with traditional approaches rather emphasizes the verbal-linguistic and mathematical-logical intelligences, whereas multiple intelligence theory-based learning approach entails the instructional process to be arranged in accordance with all intelligence profiles. In multiple intelligence theory-based learning approach, instructional process is planned after exploring how learners learn. In other words, multiple intelligence theory-based learning approach is not centered around a single intelligence profile but several of them (Durmuş & Özdemir, 2013). Thus, learners are better able to organize and comprehend information. Thanks to this approach learners can be provided with positive gains including senses of responsibility, self-efficacy, and autonomy, decrease in discipline problems, cooperation skills, and promoted academic achievement (Campbell, 1991). Previous studies in Turkey revealed that instruction based on multiple intelligence theory increased learners' mathematics achievement (Aydoğan, 2006; Işık, Tarım & İflazoğlu, 2007; Kuloğlu, 2005; Saydam, 2005; Şengül & Öz, 2006; Tufan, 2011; Yıldırım, 2006), learners' attitudes and retention levels (Altuntaş, 2007; Torun, 2009; Durmuş, 2013) and learner participation (Boztepe, 2010; Ercan, 2008; Hazer, 2013).

Another contemporary learning approach is cooperative learning approach. Cooperation-based learning "is a term used to define instructional processes where learners work in small groups to achieve shared learning objectives and are rewarded for their cooperative successes" (Ekinci, 2005, s. 92). In cooperative learning, learners learn in small groups by helping each other. Recent research have reported that cooperative learning has positive effects on learning and enhance mathematics achievement (Arısoy & Tarım, 2013; Kurtuluş & Kılıç, 2009; Ural, Umay & Argün, 2008; Ural& Argün, 2010), as well as learners' attitudes towards mathematics (Akay, 2011; Doğan, 2012; Gelici& Bilgin, 2012; Özdoğan, 2008; Özsarı, 2009), level of retainment (Arısoy& Tarım, 2013; Pınar, 2007; Ünlü& Aydıntan, 2011; Yıldırım& Tarım, 2008), and sense of self-efficacy (Ural, Umay& Argün, 2008; Ural& Argün, 2010). On the other hand, some

studies (Altunsoy, 2007; Kuzucuoğlu, 2006; Varank & Kuzucuoğlu, 2007) revealed that cooperative learning does not have a contribution to learners' mathematics achievement.

A third popular contemporary approach as an alternative to the traditional instructional approach is problem-based learning. Problem-based learning approach is based on having learners learn by understanding and resolving real life problems, thus enhancing learners' active participation and long term retention of the knowledge (Erdem, 2005). Learners produce solutions to the problem presented by the teacher using their pre-existing knowledge and support each other's learning in this respect (Kaptan & Korkmaz, 2001). Problem-based learning approach offers learners the opportunity to arrange their own learning process, thus enabling them have access to the knowledge in more detail (Günhan & Başer, 2008). Previous research revealed that using problem-based learning approach in mathematics teaching increased students' academic achievement (Akın, 2009; Apaçık, 2009; Günhan& Başer, 2008; Özgen, 2007; Öztuncay, 2005; Uslu, 2006; Usta, 2013; Uygun, 2010), positively affected learners' attitudes towards mathematics (Akın, 2009; Günhan & Başer, 2008; Özgen, 2007; Öztuncay, 2005; Uslu, 2006), made positive contribution to levels of retention (Apaçık, 2009; Özgen, 2007; Öztuncay, 2005; Uslu, 2006; Uygun, 2010), increased learners' levels of self-efficacy (Öztuncay, 2005; Usta, 2013) and improved their higher-order thinking skills including reasoning and critical thinking (Akın, 2009; Usta, 2013).

A more comprehensive alternative approach to traditional teaching is constructivist learning approach. Constructivism has been the subject of many research studies (Şahin, 2003). In traditional terms, learning and teaching process is mainly based on the transmission of knowledge from teacher to the learners, and the repetition and memorization of the learned content, whereas in constructivist learning approach, learning is based on transfer and reconstruction of learners' previous knowledge (Demirel, 2010). Constructivist educational approach aims to develop learners' higher-order thinking skills including critical thinking, judging, organizing, and interpreting personal experiences in a social context (Brooks & Brooks, 1999; Vygotsky, 1978). The construction of knowledge by the individual is facilitated by the adaptation and appropriate assimilation of the knowledge and experiences individuals obtained through their interaction with the environment (Akyol, 2006). Unlike the traditional teacher-centered approaches, constructivism re-defines the teachers' role as a scaffolder who facilitates the learner's development (Gürbüztürk & Şad, 2009). According to constructivist approach, teacher is not the person who is responsible for transmitting the knowledge directly making the learner passive receivers, but the guide who is responsible to arrange the most favorable conditions to enable the learners construct the knowledge through their own experiences. The learner compares the new information with his/her previous knowledge and assimilates it or creates new schemes (Güneş & Asan, 2005). Previous research showed that instructional processes based on constructivist learning approach enhance learners' mathematics achievement (Akyol, 2006; Başer, 2008; Besler, 2009; Çiftçi, 2010; Deniz, 2009; Özerbaş, 2007; Pulat, 2009; Şişman, 2007), positively affect their attitudes towards mathematics (Akyol, 2006; Çiftçi, 2010; Deniz, 2009), enhance their level of retention (Akyol, 2006; Özerbaş, 2007), and increase students' active participation (Güneş & Asan, 2005). However, there are also, rather few, studies in the literature which found that instructional processes designed in accordance with constructivist approach had no positive effect on achievement (Güneş & Asan, 2005) or attitudes (Pulat, 2009).

As summarized above, many experimental studies tested the effect of contemporary learning approaches on learners' mathematics achievement. However, there is a need to synthesize the findings of these individual studies with a meta-analysis study in order to better use and interpret the obtained cumulative data. In meta-analysis, many individual studies conducted about a certain topic are synthesized thus increasing the sample size and the amount of data; and thanks to combination and comparison of more data, it becomes possible to describe certain

characteristics of the studied phenomenon using the yielded effect sizes (Büyüköztürk, Çakmak, Akgün, Karadeniz& Demirel, 2011; Çelik, 2013; Göçmen, 2004).

There are a few meta-analysis studies in Turkey which have synthesized the results of individual studies investigating the effect of different contemporary learning approaches on learners' mathematics achievement (e.g. Batdı, 2014; Çelik, 2013; Özdemirli, 2011; Şen & Yılmaz, 2013; Tarım, 2003). There seems to be a need for a meta-analytic effect size analysis to explore the effect of contemporary learning approaches on learners' mathematics achievement. Accordingly, the present study examined 47 experimental studies which investigated the effect of contemporary learning approaches on learners' mathematics achievement, and in this respect main research question was developed as "Do contemporary learning approaches have a significant effect on learners' mathematics' achievement?".

### 1.1. Purpose of the Study

The purpose of the study is to synthesize the findings of the individual studies which investigated the effects of using contemporary learning approaches in mathematics lessons including cooperative learning, multiple intelligence-based learning, problem-based learning, and constructivist learning on students' mathematics achievement via meta-analysis method. Answers to following research questions were sought:

1) What is the combined size of the effect of contemporary learning approaches on learners' academic achievement in mathematics lesson?

2) Does the combined size of the effect of contemporary learning approaches on learners' academic achievement in mathematics differ significantly according to:

a) the specific contemporary learning approach (cooperative, multiple intelligence, problem-based, and constructivist),

b) students' study year?

3) Is there a significant correlation between the size of the effect of contemporary learning approaches and

a) the duration of experiment,

b) the number of students involved in the experiment?

## 2. METHOD

### 2.1. Design of the study

The study is based on meta-analysis method. Meta-analysis is a method which collects many individual and independent studies about a certain topic and re-analyzes their findings statistically. In the meta-analytic examination of experimental studies, the aim is twofold. One is to calculate the overall effect size of learning approaches used in experimental groups and the other is to describe the studies' characteristics using the effect size (Cumming, 2012; Ellis, 2012; Petticrew and Roberts, 2006). Individual studies included in this meta-analytic study examine each approach's impact on learners' academic achievement in mathematics separately. In the present study, however, meta-analysis method was used in order to determine the synthesized overall effect size of using contemporary learning approaches such as cooperative learning, multiple intelligence-based learning, problem-based learning and constructivist learning.

## *2.2. The Studies Included and Data Collection Process*

The meta-analysis included studies published between 2005 and 2014 which focus on the contemporary learning approaches' impact on academic achievement in mathematics. The Turkish and English versions of the following keywords or descriptors were entered for search in databases such as EBSCO, YÖK (Higher Education Council), ULAKBIM and Google Scholar search engine: *teaching mathematics*, *mathematics* AND *multiple intelligence theory*, *multiple intelligence; mathematics* AND *cooperative learning (with synonyms like 'kubaşık öğrenme'); mathematics* AND *problem based learning*, *mathematics* AND *constructivist learning*, *constructivist learning theory (with synonyms like oluşturmacı yaklaşım),* and *experiment**. The resulting matches were examined by the researchers to sort out experimental studies testing the effect of relevant contemporary learning approaches on learners' math achievement at different levels.

In this context, a total of 47 peer-reviewed academic journal articles, or master and doctoral theses were included into the meta-analysis. Included studies were indicated with an asterisk sign (*) in references. A total of 2548 participants (1252 in experimental groups and 1296 in control groups) took place in the 44 studies. In remaining 3 studies (Besler, 2008; Pulat, 2009; Tufan, 2011), there were no control groups and only pre-test and post-test scores of subjects in experimental groups (n=79) were compared. Thus, in this meta-analysis, the data obtained from a total of 2627 subjects were used to synthesize the academic achievement in mathematics with contemporary learning approaches. Table 1 shows descriptive statistics.

**Table 1. Descriptive statistics of studies included in the meta-analysis**

| Variable | Group | f | % |
|---|---|---|---|
| Contemporary Learning Approach | Cooperative | 16 | 34 |
| | Multiple Intelligence | 13 | 28 |
| | Problem-Based | 9 | 19 |
| | Constructivist | 9 | 19 |
| | Total | 47 | 100 |
| Class Level | Kindergarten | 1 | 2 |
| | 2nd Grade | 1 | 2 |
| | 3rd Grade | 4 | 9 |
| | 4th Grade | 8 | 17 |
| | 5th Grade | 12 | 26 |
| | 6th Grade | 8 | 17 |
| | 7th Grade | 8 | 17 |
| | 8th Grade | 4 | 9 |
| | 9th Grade | 1 | 2 |
| | Total | 47 | 100 |
| Stages of school | Pre-school | 1 | 2 |
| | Primary school | 13 | 28 |
| | Secondary school | 28 | 60 |
| | High School | 5 | 11 |
| | Total | 47 | 100 |
| Type of Publication | Peer reviewed national articles | 12 | 26 |
| | Peer reviewed international articles | 2 | 4 |
| | Master thesis | 30 | 64 |
| | Doctoral thesis | 3 | 6 |
| | Total | 47 | 100 |
| *Duration of experimental process (lesson hour) min= 6h; max= 75h; mean= 25,86, sd= 16,26 | | | |
| *Number of subjects involved in the experiment min= 11; max= 56; mean= 28,8; sd= 9,48 | | | |

Table 1 shows that 16 studies (34%) are about cooperative learning, 13 studies (28%) are about multiple intelligence, 9 studies are about (19%) problem-based learning and 9 studies (19%) are about constructivist learning approaches examining the academic achievement of students in mathematics. Table 1 also shows that in class level, most of the studies (k=12; 26%) were from 5th grade. In teaching level most of the studies were from secondary school (k=28, 60%), and in terms of publication type, most of them were master dissertations (k= 30, 64%).

The number of subject students took part in experimental groups ranged between 11 and 56, with an average of 28,8 (sd=9,48) and duration of experimental process was at least 6 hours and at most 75 hours, with an average of 25,86 (sd=16,26) course hours.

### *1.1 2.3. The Criteria for Selection of Studies Included*

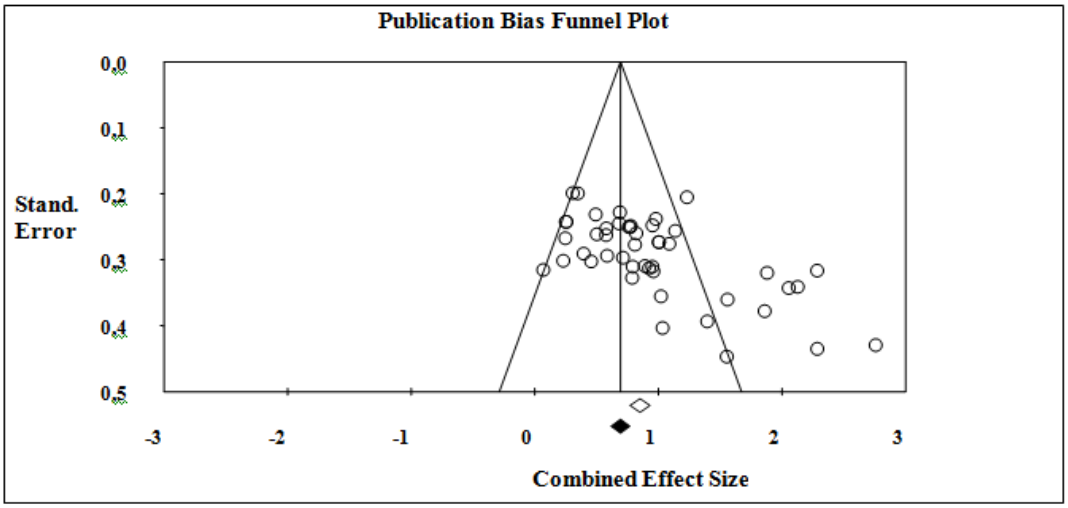
The following criteria were used to include the studies into the meta-analysis:

1. The studies with pre-test and post-test control groups and single group pre-test and post-test studies were included into the meta-analysis.
2. Accessible full-text academic journal articles, master and doctoral dissertations were included into the meta-analysis.
3. In order to calculate effect sizes, the studies reporting quantitative data such as sample size, mean scores, standard deviations, *F*, *t*, $X^2$ and p values were included into the meta-analysis.

### *1.2 2.4. The Validity and Reliability of the Study*

All included studies' validity and reliability analysis results were checked to ensure the validity and reliability of the present meta-analysis study. In the coding process, inter-rater reliability was tested using Cohen's Kappa statistics. When raters' opinions were different, consensus was reached after discussion and persuasion processes.

When it comes to publication bias, funnel plot was examined visually and also Orwin's Fail-Safe N was calculated. Graph 1 shows that the majority of 47 studies are positioned on both sides of overall effect size symmetrically and towards the upper part of the graph. When there is no publication bias, the included studies are scattered symmetrically on both sides of combined effect size vertical line. However, in case of publication bias, the majority of studies are placed on one side of the line and towards the bottom (Borenstein, Hedges, Higgins, & Rothstein, 2009). Graph 1 shows that for this meta-analysis there seem no publication bias.




**Graph 1. Funnel plot of publication bias**

Moreover, Orwin's Fail-Safe N was used to determine the number of missing studies in meta-analysis as a measure of testing publication bias (Borenstein et al., 2009). For this study, Orwin's Fail-Safe N was calculated as 3956. Thus, in order to get the calculated combined effect size of 0.851 to trivial level of -0.01 (almost zero), 3956 more studies are needed, which is about 84 times more than the number of included studies. However, 47 studies included in the present meta-analysis are all attainable studies after a rigorous search (qualitative, quantitative, and theoretical) in all attainable library catalogues and digital databases on the topic. Accordingly, this indicates that present meta-analysis has no publication bias.

### *1.3 2.5. Data Analysis*

It is the effect size of each study that is used in the meta-analysis in order to calculate the combined effect size of the studies thereby checking the significance statistically (Çelik, 2013). Mostly Cohen's d formula is chosen when comparing and combining the findings of studies with two independent groups (Cumming, 2012; Ellis, 2012; Petticrew and Roberts, 2006). According to Cohen (1988), the overall effect sizes between 0.20-0.50 is low, 0.50-0.80 is medium, and 0.80 and above is high.

The meta-analyses of the results of the studies were done using two models: fixed effect model and random effect model (Cumming, 2012; Petticrew and Roberts, 2006). In this study, effect size for each study was calculated and heterogeneity of all effect sizes were evaluated, thus the model was chosen at the end accordingly.

In the study, effect sizes, variances for each study and group comparisons were calculated using the statistical software for meta-analysis, Comprehensive Meta-analysis (CMA) version 2.0 (Borenstein et al., 2009). Quantitative data consisted of experimental groups' and control groups' pre-test and post-test scores. Thus, a positive overall combined effect size value is interpreted in favor of experimental group or experimental groups' post-test, whereas a negative value is interpreted in favor of control group or experimental pre-test. The level of significance was considered 0.05.

## 3. FINDINGS

### 3.1. Combined Effect Size of Contemporary Learning Approaches on Learners' Mathematics Achievement

Table 2. shows calculated effect sizes for each of the included studies and combined effect sizes in fixed and random effect model (outliers included) with standard error, lower - upper limits according to 95% confidence interval, z and p values related to the effectiveness of experimental effect.

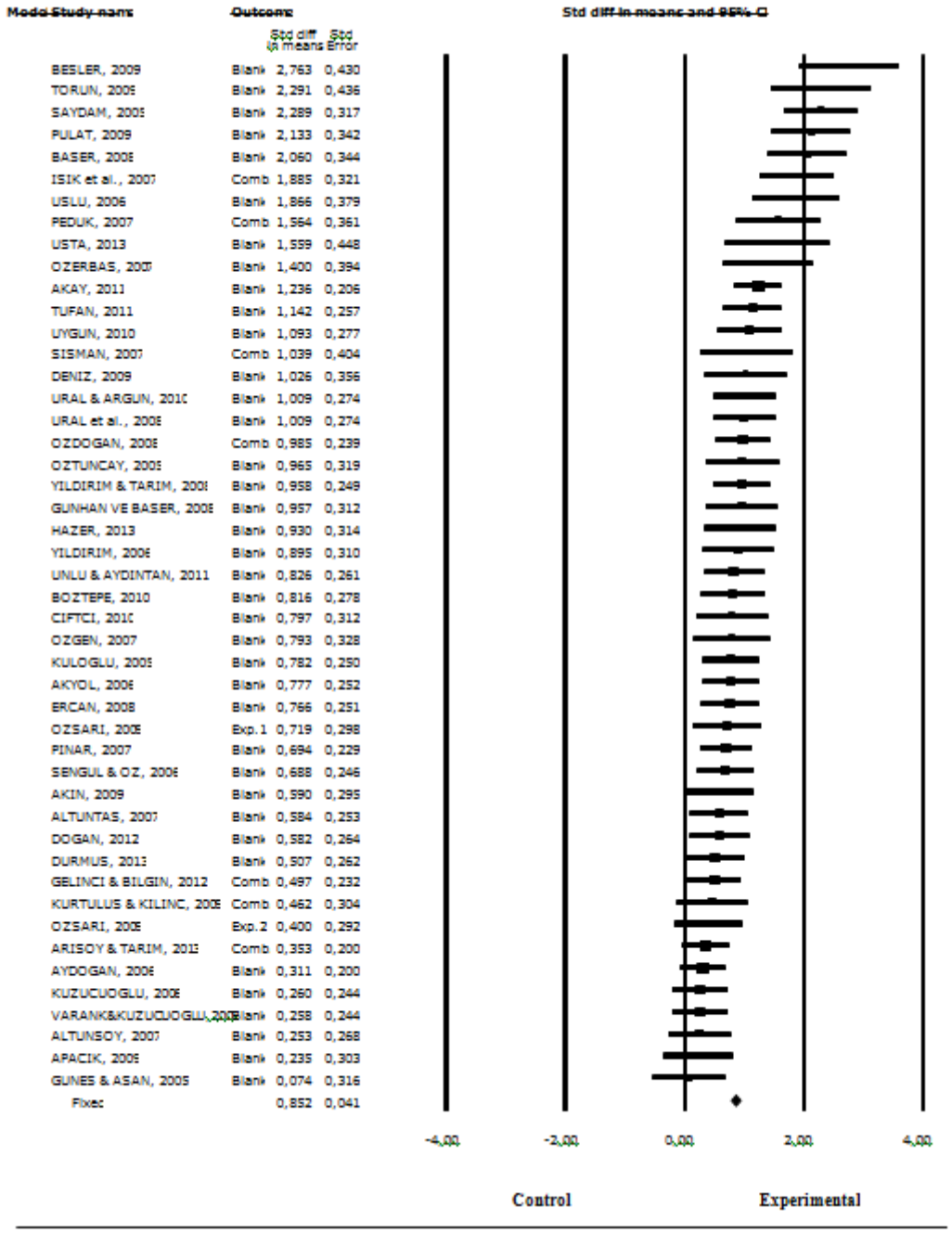
As seen in Table 2, out of 47 studies, 37 had statistically significant differences in favor of experimental group/post-test ($p<.05$), whereas 10 studies (Altunsoy, 2007; Apaçık, 2009; Aydoğan, 2006; Arısoy & Tarım, 2013; Durmuş, 2013; Güneş & Asan, 2005; Kurtuluş & Kılınç, 2009; Kuzucuoğlu, 2006; Özsarı, 2009; Varank & Kuzucuoğlu, 2007) had no statistically significant difference ($p>.05$). For all 47 studies, Standardized Mean Difference (SMD) was calculated 0.85 for *Fixed Effect Model* and 0.93 for *Random Effect Model* both in favour of experimental group/post-test. Both effect sizes fall into *large effect size* according to Cohen's (1998) benchmark. According to these effect sizes, it can be said that using contemporary learning approaches in mathematics teaching can increase effectively the students' math achievement.

**Table 2. Statistics of experimental effect in included studies**

| Study ID | Cohen d | Std Error | $S^2$ | Confidence Interval (%95) | | z | p |
|---|---|---|---|---|---|---|---|
| | | | | Lower limit | Upper limit | | |
| Besler, 2009 (CON) | 2,76 | 0,43 | 0,19 | 1,92 | 3,61 | 6,42 | 0,000 |
| Torun, 2009 (COOP) | 2,29 | 0,44 | 0,19 | 1,44 | 3,15 | 5,25 | 0,000 |
| Saydam, 2005 (MI) | 2,29 | 0,32 | 0,10 | 1,67 | 2,91 | 7,21 | 0,000 |
| Pulat, 2009 (CON) | 2,13 | 0,34 | 0,12 | 1,46 | 2,80 | 6,24 | 0,000 |
| Başer, 2008 (CON) | 2,06 | 0,34 | 0,12 | 1,39 | 2,73 | 5,99 | 0,000 |
| Işık et al., 2007 (MI) | 1,89 | 0,32 | 0,10 | 1,26 | 2,51 | 5,88 | 0,000 |
| Uslu, 2006 (PB) | 1,87 | 0,38 | 0,14 | 1,12 | 2,61 | 4,92 | 0,000 |
| Pedük, 2007 (MI) | 1,56 | 0,36 | 0,13 | 0,86 | 2,27 | 4,33 | 0,000 |
| Usta, 2013 (PB) | 1,56 | 0,45 | 0,20 | 0,68 | 2,44 | 3,48 | 0,001 |
| Özerbaş, 2007 (CON) | 1,40 | 0,39 | 0,16 | 0,63 | 2,17 | 3,55 | 0,000 |
| Akay, 2011 (COOP) | 1,24 | 0,21 | 0,04 | 0,83 | 1,64 | 5,99 | 0,000 |
| Tufan, 2011 (MI) | 1,14 | 0,26 | 0,07 | 0,64 | 1,65 | 4,44 | 0,000 |
| Uygun, 2010 (PB) | 1,09 | 0,28 | 0,08 | 0,55 | 1,64 | 3,95 | 0,000 |
| Şişman, 2007 (CON) | 1,04 | 0,40 | 0,16 | 0,25 | 1,83 | 2,57 | 0,010 |
| Deniz, 2009 (CON) | 1,03 | 0,36 | 0,13 | 0,33 | 1,73 | 2,88 | 0,004 |
| Ural & Argun, 2010 (COOP) | 1,01 | 0,27 | 0,08 | 0,47 | 1,55 | 3,68 | 0,000 |
| Ural, Umay & Argun, 2008 (COOP) | 1,01 | 0,27 | 0,08 | 0,47 | 1,55 | 3,68 | 0,000 |
| Özdoğan, 2008 (COOP) | 0,99 | 0,24 | 0,06 | 0,52 | 1,45 | 4,12 | 0,000 |
| Öztuncay, 2005 (PB) | 0,96 | 0,32 | 0,10 | 0,34 | 1,59 | 3,03 | 0,002 |
| Yıldırım & Tarım, 2008 (COOP) | 0,96 | 0,25 | 0,06 | 0,47 | 1,45 | 3,85 | 0,000 |
| Günhan & Başer, 2008 (PB) | 0,96 | 0,31 | 0,10 | 0,35 | 1,57 | 3,07 | 0,002 |
| Hazer, 2013 (MI) | 0,93 | 0,31 | 0,10 | 0,31 | 1,54 | 2,96 | 0,003 |
| Yıldırım, 2006 (MI) | 0,90 | 0,31 | 0,10 | 0,29 | 1,50 | 2,88 | 0,004 |
| Ünlü & Aydıntan, 2011 (COOP) | 0,83 | 0,26 | 0,07 | 0,31 | 1,34 | 3,16 | 0,002 |
| Boztepe, 2010 (MI) | 0,82 | 0,28 | 0,08 | 0,27 | 1,36 | 2,93 | 0,003 |
| Çiftçi, 2010 (CON) | 0,80 | 0,31 | 0,10 | 0,19 | 1,41 | 2,56 | 0,011 |
| Özgen, 2007 (PB) | 0,79 | 0,33 | 0,11 | 0,15 | 1,44 | 2,42 | 0,016 |
| Kuloğlu, 2005(MI) | 0,78 | 0,25 | 0,06 | 0,29 | 1,27 | 3,13 | 0,002 |
| Akyol, 2006 (CON) | 0,78 | 0,25 | 0,06 | 0,28 | 1,27 | 3,09 | 0,002 |
| Ercan, 2008 (MI) | 0,77 | 0,25 | 0,06 | 0,27 | 1,26 | 3,05 | 0,002 |
| Özsarı, 2009 (PB-Experiment 1) | 0,72 | 0,30 | 0,09 | 0,13 | 1,30 | 2,41 | 0,016 |
| Pınar, 2007 (COOP) | 0,69 | 0,23 | 0,05 | 0,25 | 1,14 | 3,03 | 0,002 |
| Şengül & Öz, 2006 (MI) | 0,69 | 0,25 | 0,06 | 0,21 | 1,17 | 2,80 | 0,005 |
| Akın, 2009 (PB) | 0,59 | 0,29 | 0,09 | 0,01 | 1,17 | 2,00 | 0,045 |
| Altuntaş, 2007 (MI) | 0,58 | 0,25 | 0,06 | 0,09 | 1,08 | 2,30 | 0,021 |
| Doğan, 2012 (COOP) | 0,58 | 0,26 | 0,07 | 0,07 | 1,10 | 2,21 | 0,027 |
| Durmuş, 2013(MI) | 0,51 | 0,26 | 0,07 | -0,01 | 1,02 | 1,93 | 0,053 |
| Gelici & Bilgin, 2012 (COOP) | 0,50 | 0,23 | 0,05 | 0,04 | 0,95 | 2,14 | 0,032 |
| Kurtuluş & Kılıç, 2009 (COOP) | 0,46 | 0,30 | 0,09 | -0,13 | 1,06 | 1,52 | 0,128 |
| Özsarı, 2009 (COOP-Experiment 2) | 0,40 | 0,29 | 0,08 | -0,17 | 0,97 | 1,37 | 0,170 |
| Arısoy & Tarım, 2013 (COOP) | 0,35 | 0,20 | 0,04 | -0,04 | 0,75 | 1,76 | 0,078 |
| Aydoğan, 2006 (MI) | 0,31 | 0,20 | 0,04 | -0,08 | 0,70 | 1,56 | 0,119 |
| Kuzucuoğlu, 2006 (COOP) | 0,26 | 0,24 | 0,06 | -0,22 | 0,74 | 1,07 | 0,286 |
| Varank & Kuzucuoğlu, 2007 (COOP) | 0,26 | 0,24 | 0,06 | -0,22 | 0,73 | 1,06 | 0,290 |
| Altunsoy, 2007 (COOP) | 0,25 | 0,27 | 0,07 | -0,27 | 0,78 | 0,94 | 0,347 |
| Apaçık, 2009 (PB) | 0,24 | 0,30 | 0,09 | -0,36 | 0,83 | 0,78 | 0,436 |
| Güneş & Asan, 2005 (CON) | 0,07 | 0,32 | 0,10 | -0,55 | 0,69 | 0,23 | 0,816 |
| **Fixed Effect** | **0,852** | **0,041** | **0,002** | **0,77** | **0,93** | **20,81** | **0,000** |
| **Random Effect** | **0,934** | **0,078** | **0,006** | **0,78** | **1,09** | **11,90** | **0,000** |

Note: CON= Constructivist; COOP= Cooperative; PB =Problem Based, and MI= Multiple Intelligence

Graph 2 shows the forest plot comprising 47 studies and related data with effect sizes in experimental studies included.




***Graph 2. Forest plot of the studies***

As seen in Graph 2, a difference above zero can be observed in favor of experimental/post-test groups. When it comes to Confidence Intervals, except for 10 studies (Durmuş, 2013; Kurtuluş & Kılıç, 2009; Özsarı, 2009; Arısoy& Tarım, 2013; Aydoğan, 2006; Kuzucuoğlu, 2006; Varank & Kuzucuoğlu, 2007; Altunsoy, 2006; Apaçık, 2009; Güneş & Asan, 2005), studies have

effect sizes ranging above zero at 95% confidence interval in favor of experimental group/post-test. Overall effect size standard error is very low, and confidence interval ranges between the lower limit of 0,77 and upper limit of 0,93 indicating a large effect.

At this stage, in order to test the heterogeneity of effect sizes of included studies, Q statistics (weighed sum of squares of effect sizes) and p value were calculated. In addition, a supplementary statistics $I^2$ was calculated, which shows the ratio of extra variance out of total variance. Table 3 shows the results of this calculation.

**Table 3. Heterogeneity analysis results of effect sizes for all studies**

| Heterogeneity | | | |
|---|---|---|---|
| **Q-value** | **Df (Q)** | **p-value** | **$I^2$** |
| 163,832 | 46 | 0.000* | 71.93 |

p< .05

In Table 3, it can be seen that Q value is statistically significant (Q=163,832; p= 0.000) for 0,05 significance level. This means that studies are heterogeneous since homogeneity hypothesis is rejected. $I^2$ value (%71.93) indicates that the 72% observed variance is due to real variance between studies. $I^2$ value with 25% shows low heterogeneity, whereas 50% is medium heterogeneity and 75% and above is high heterogeneity (Cooper, Hedges & Valentine, 2009). Thus, homogeneity tests (Q and $I^2$) showed statistically significant difference between studies in terms of effect sizes. As a result, random effect model for this meta-analysis is more appropriate and all calculations were done using this model.

Borenstein et al. (2009) state that moderator analysis should be done in order to determine possible reasons of heterogeneity between studies. Therefore, analyses for some moderators were also done to discover the reasons of heterogeneity.

## 3.2. Moderator Analysis of Learning Approaches (Multiple Intelligence, Problem Based, Cooperative, and Constructivist)

As the first moderator, four categorical subgroups were determined regarding the contemporary learning approaches (multiple intelligence, cooperative, problem-based and constructivist). Next, summary effect sizes for each category were calculated and compared using random effect model. Comparison results are given in Table 4.

**Table 4. Moderator analysis results in random effect model in terms of contemporary learning approaches' effects on academic achievement in mathematics**

| | | | | | Confidence Interval (95%) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Moderator (Learning Approachs)** | **Number of Studies (k)** | **Cohen d** | **SE** | **S** | **Lower limit** | **Upper limit** | **z** | **p** | **Q** | **Df(Q)** | **p** |
| Multiple Intelligence | 13 | 0,978 | 0,144 | 0.021 | 0,696 | 1.259 | 6.799 | .000* | | | |
| Cooperative | 16 | 0,724 | 0,128 | 0.016 | 0,474 | 0.974 | 5.678 | .000* | | | |
| Problem Based | 9 | 0,941 | 0,182 | 0.033 | 0,584 | 1.298 | 5.170 | .000* | | | |
| Constructivist | 9 | 1,290 | 0,186 | 0.035 | 0,925 | 1.656 | 6.925 | .000* | | | |
| Between groups | | | | | | | | | 6.456 | 3 | 0.091 |
| Total | 47 | 0,966 | 0,132 | 0.017 | 0,706 | 1.225 | 7.302 | .000* | 163.832 | | |

p < .05

According to the results, the effect of using multiple intelligence approach (k=13) on mathematic achievement was found to be statistically significant (z=6.799, p< .05) and large (d=0.978). For cooperative learning (k=16), effect size (d) was 0.724, statistically significant and almost large effect (z=5.678, p<.05). For problem based approach (k=9), it was 0.941, large

effect, and statistically significant (z=5.170, p <.05). For the last subgroup, the combined effect size for the studies testing constructivist approach (k=9) was 1.290, large and statistically significant (z=6.925, p<.05). Results of between groups analysis revealed that there is no statistically significant difference between each learning approach's effect on academic achievement in mathematics ($Q_{BG}$=6.456, df=3, p=0.091).

## 3.3. Moderator Analysis of Teaching Level (Primary, Secondary and High School) for the Effect of Contemporary Learning Approaches on Academic Achievement in Mathematics

Teaching level was chosen as a moderator since the number of studies in each class level was not sufficient for each meta-analysis. One study (Pedük, 2007) was not included into the analysis since it was the only study at pre-school level. Effects sizes of 46 studies were calculated and compared in terms of stages of school: primary, secondary and high school. Comparison results were given in Table 5.

**Table 5. Moderator analysis (teaching level) results in random effect model in terms of contemporary learning approaches' effects on academic achievement in mathematics**

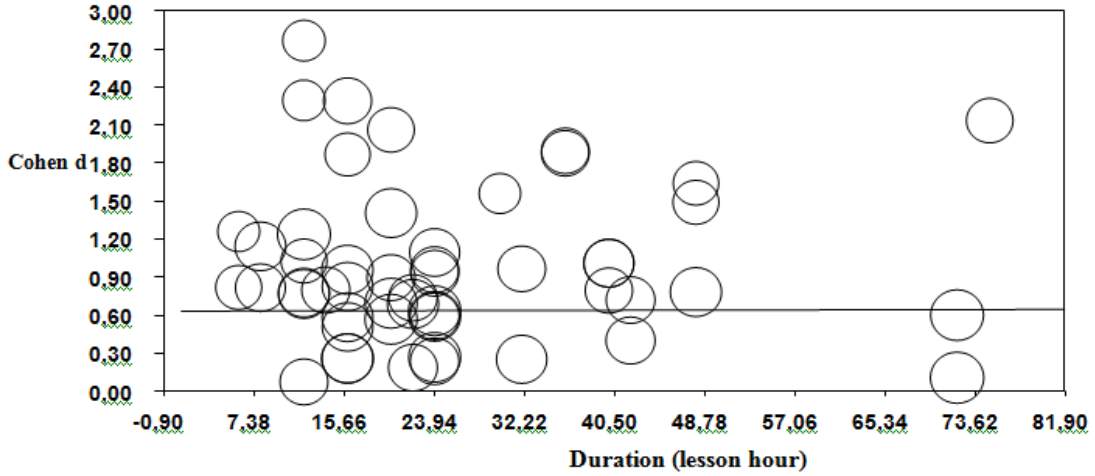
| | | | | | Confidence Interval (95%) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Moderator (School stage)** | **Number of Studies (k)** | **Cohen d** | **SE** | **S** | **Lower limit** | **Upper limit** | **z** | **p** | **Q** | **Df(Q)** | **P** |
| Primary | 13 | 0,673 | 0,146 | 0.021 | 0.387 | 0.960 | 4.609 | .000* | | | |
| Secondary | 28 | 1.034 | 0.101 | 0.010 | 0.836 | 1.232 | 10.219 | .000* | | | |
| High School | 5 | 0,958 | 0,243 | 0.059 | 0,482 | 1.434 | 3.943 | .000* | | | |
| Between Groups | | | | | | | | | 4.136 | 2 | 0.126 |
| Total | 46 | 0,891 | 0,142 | 0.020 | 0,613 | 1.169 | 6.272 | .000* | | | |

p< .05

According to the analyses results, it was found that effect size of contemporary learning approaches in primary school (k=13) on mathematic achievement was 0.661, medium effect, and statistically significant (z=4.609, p< .05). For secondary school (k=28), it was 0.915, large effect, and statistically significant (z=10.219, p<.05). Similarly, for high school (k=5), it was 0.926, large effect, and statistically significant (z=3.943, p <.05). Between groups analysis results indicate that there is no statistically significant difference between the combined effect sizes of studies conducted at different school stages ($Q_{BG}$=4.136, df=2, p=0.126).

## 3.4. The relationship between duration of experiment and effect sizes of contemporary learning approaches on academic achievement in mathematics

Graph 3 and Table 6 show the meta-regression analysis results between experimental duration (class hour) and effect size changes of contemporary learning approaches. As seen in Graph 3, experimental duration varies between 7,38 and 32,22 lesson hours, and effect sizes range between 0.60 - 1.20. When it comes to the relationship, effect size dispersion indicates a slope near zero.




***Graph 3. Meta-regression analysis of experiment duration and effect sizes in random effect model***

Table 6 shows regression coefficient as -0,00024, yet it is not statistically significant (z= -0,04990, p>0.05). Thus, it can be said that in experimental studies testing the impact of contemporary learning approaches on learners' math performance, experiment duration has no effect in terms of students' academic achievement in mathematics.

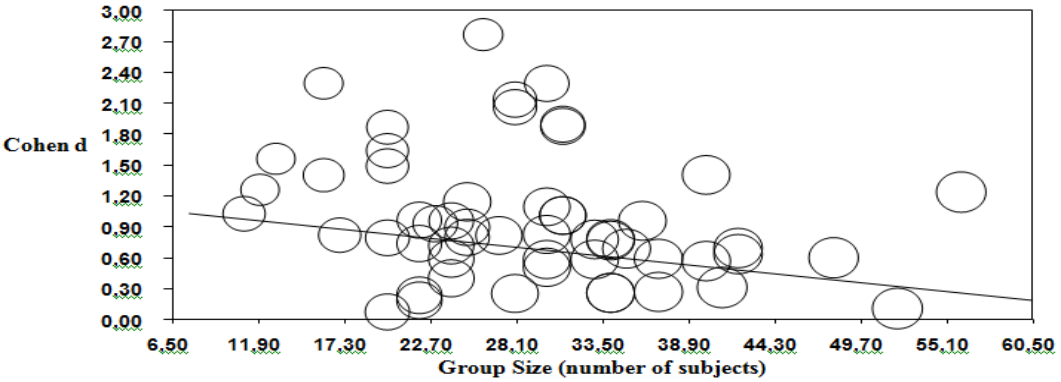
**Table 6. Meta-regression analysis of the duration of experiment and effect sizes in random effect model**

| | | | Confidence Interval (95%) | | | |
|---|---|---|---|---|---|---|
| **Regression Coefficient** | | **SE** | **Lower Limit** | **Upper Limit** | **z** | **p** |
| Experiment duration | -0,00024 | 0,00475 | -0.00956 | 0.00908 | -0.04990 | 0.96020 |
| Intercept | 0.94531 | 0.14627 | 0.65863 | 1.23199 | 6.46291 | 0.00000 |

p < .05

## 3.5. The relationship between experiment subject number and effect sizes of contemporary learning approaches on academic achievement in mathematics

Graph 4 and Table 7 show the meta-regression analysis results between group size (number of subjects in experiment) and effect sizes of contemporary learning approaches. As seen in Graph 4, group size ranges between 17,30 and 38,90 subjects, and effect sizes range between 0.60 and 1.20. The dispersion of effect sizes shows a negative sharp slope.




***Graph 4. Meta-regression analysis of group size (number of subjects) and effect sizes in random effect model***

Table 7 shows regression coefficient as -0,01624, and it is statistically significant (z= -2,12076, p<0.05). Thus, it can be said that in experimental studies of contemporary learning approaches, one unit decrease in group size (number of students) causes an increase of 0,01624 in effect size. Therefore, it can be said that, in lessons in which contemporary learning approaches are used, the fewer the number of students, the higher statistically significant effect sizes we get.

**Table 7: Meta-regression analysis of group size (number of subjects) and effect sizes in random effect model**

| | | | Confidence Interval (95%) | | | |
|---|---|---|---|---|---|---|
| **Regression Coefficient** | | **SE** | **Lower Limit** | **Upper Limit** | **z** | **p** |
| Group Size | -0,01624 | 0,00766 | -0.03125 | -0.00123 | -2.12076 | 0.03394* |
| Intercept | 1.40660 | 0.23945 | 0.93729 | 1.87590 | 5.87439 | 0.00000 |

p< .05

## 4. DISCUSSION and RESULTS

This study aimed at synthesizing the findings of the studies which investigated the effects of contemporary learning approaches used in mathematics lessons (i.e. cooperative learning, multiple intelligence-based learning, problem-based learning, and constructivist learning approaches) on students' mathematics achievement via meta-analysis method. To this end, meta-analysis included studies published between 2005 and 2014 which focused on the effect of using contemporary learning approaches' on learners' academic achievement in mathematics.

Out of 47 studies which investigated the effect of contemporary learning approaches on learners' academic achievement in mathematics lesson and met the meta-analysis inclusion criteria, 37 had statistically significant differences in favor of experimental group/posttest (p<.05), whereas 10 studies had confidence interval limits (95%) exceeding positive limits (p<.05). Standardized Mean Difference (SMD) calculated for all 47 studies was 0.85 according to Fixed Effect Model and 0.93 according to Random Effect Model in favor of experimental group/posttest.

As a result of the heterogeneity test applied to test whether the included studies are homogeneous in terms of their real effect sizes, the Q statistics (163,832; p= 0.000) was found to be significant at 0.05 level, which meant the effect sizes of the studies were heterogeneous. Moreover, estimated $I^2$ (71.93) value showed that about 72% of the observed variance was due to the real differences between the effect sizes of the studies. As a result, it was decided that random effects model is appropriate and all calculations were done using this model. According to Random Effect Model the effect size was calculated 0.93 in favor of experimental group/post-test, which is equal to large effect according to Cohen's (1998) benchmark. These results suggested that using contemporary learning approaches in teaching mathematics is effective in enhancing students' achievement in math. The large effect size (d=0.93) obtained in the present study is consistent with the large effect size (0.887) obtained by Çelik (2013) in the meta-analysis of studies which investigated the effect of alternative teaching methods on mathematics achievement.

As a result of moderator analysis, using multiple intelligence theory-based learning (k=13) had a large combined effect (d=0.978) on learners' mathematics achievement; while using cooperative learning approach (k=16) had a medium-to-large effect (d=0.724); using problem based approach (k=9) had a large effect (d=0.941), and lastly using constructivist approach (k=9) had the largest effect (d=1.290). The between-groups comparison (with random effect model) to check whether the sizes of effects of contemporary learning approaches on mathematics achievement differ according to specific learning approach yielded no statistical significance between the effects of applied learning approach on learners academic achievement in

mathematics ($Q_{BG}$=6.456, Df=3, p=0.091). Especially the effect size calculated for the studies testing the effect of cooperative learning was lower than the large effect sizes obtained in previous meta-analysis studies by Batdı (2014), Şen & Yılmaz (2013), Tarım (2003) and Çelik (2013). The finding regarding the large effect sizes estimated for multiple intelligence theory-based learning, problem-based learning, and constructivist learning approaches was in consistency with the findings in Çelik (2013).

The results of the analysis for the moderator of school stage revealed that combined size of the effects of using contemporary learning approaches on mathematic achievement was medium (d=0.661) at primary school stage (k=13), large (d=0.915) at secondary school stage (k=28), and large (d=.926) at high school stage (k=5). Between-groups analysis results revealed no statistically significant difference between the combined effect sizes of studies conducted at different stages of schools ($Q_{BG}$=4.136, df=2, p=0.126). Based on this finding it can be concluded that using contemporary learning approaches in all three major stages of education (primary, secondary and high school) has a similar positive contribution to learners' academic achievement regarding mathematics.

The results of meta-regression analysis regarding the effect of duration of experimental process (lesson hours) on the effect sizes of studies learners revealed no significant impact of duration (z= -0,04990, p> 0.05). Considering the combined large effect size for all studies, it can be concluded that contemporary learning approaches are effective on students' academic achievement regardless of the time experimental treatment took place.

The results of meta-regression analysis regarding the effect of number of students involved in experimental groups on the effect sizes of studies learners revealed a significant impact (z= -2,12076 , p< 0.05). The estimated regression coefficient (-0,01624) suggests that one unit of decrease in group size (number of students) causes a significant increase in effect size by 0,01624. Thus, it can be concluded that the effect of contemporary learning approaches on mathematics achievement gets improved when the number of students decreases.

Finally following recommendations can be made for practitioners and researchers:

1) Since it was found that the effect of contemporary learning approaches on mathematic achievement increases as the number of students decreases, it is recommended that mathematics teachers should use contemporary learning approaches in small groups as much as possible.

2) The present research investigated the effect of using contemporary learning approaches on learners' mathematics achievement. Future research can extend the scope of the dependent variables to include attitude, anxiety and self-efficacy, which are also important in terms of students' mathematics achievement.

3) Present study which investigated the impact of contemporary learning approaches on learners' mathematics achievement using the meta-analysis method was confined to the national studies only. Future meta-analysis studies can compare national and international researches to get more objective and comprehensive results.

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## Uzun Özet

Milli Eğitim Bakanlığı tarafından 2004 yılında öğrencilerin zihinsel ve fiziksel olarak daha aktif oldukları bir eğitim-öğretim anlayışının geliştirilmesi amacıyla kapsamlı çalışmalar başlatılmıştır. Bu bağlamda yenilenen programlardan biri de matematik dersi öğretim programıdır. Yenilenen programla birlikte öğretim sürecinde geleneksel öğretim yaklaşımları yerine çağdaş öğrenme yaklaşımlarına (çoklu zekâ kuramına dayalı öğrenme, işbirlikli öğrenme, probleme dayalı öğrenme, yapılandırmacılık yaklaşımları vs.) daha çok yer verilmiştir. Bu öğrenme yaklaşımları öğretim sürecinde öğrenciyi merkeze alan, öğrencinin kendi potansiyelini kullanabileceği, öğrencinin öğrenme yöntemleri, beceri ve ilgileri, geçmişten getirdiği tecrübeleri vasıtasıyla ve bulunduğu sınıftaki arkadaşları ile işbirliği içerisinde öğrenmenin organize edilmesine yardımcı olan bir anlayışı içerir (Titiz, 2005). Ülkemizde farklı çağdaş

öğrenme yaklaşımlarının, öğrencilerin matematik akademik başarıları üzerine etkisini inceleyen bireysel çalışmaların sonuçlarını meta analiz yöntemi ile birleştiren az sayıda çalışmaya rastlanmıştır. Çağdaş öğrenme yaklaşımlarının öğrencilerin matematik akademik başarıları üzerindeki etkisini daha geniş kapsamlı ortaya çıkarmak amacıyla bir meta analitik etki analizine ihtiyaç duyulduğu görülmektedir. Bu araştırmada çağdaş öğrenme yaklaşımlarının matematik başarısına etkisini incelemek amacıyla 47 çalışma incelenmiş ve bu bağlamda "çağdaş öğrenme yaklaşımlarının öğrencilerin matematik dersindeki akademik başarılarına etkisi ne düzeydedir?" sorusuna cevap aranmıştır.

Bu araştırmada çağdaş öğrenme yaklaşımları kapsamında değerlendirilen işbirlikli öğrenme, çoklu zekâ kuramına dayalı öğrenme, probleme dayalı öğrenme ve yapılandırmacı öğrenme yaklaşımlarının matematik dersi akademik başarısına etkisinin incelendiği deneysel çalışmalardan elde edilen bulguların meta-analiz yoluyla sentezlenmesi amaçlanmıştır.

Verilerin toplanması için dâhil edilme kriterleri belirlenip kodlama formu hazırlanmıştır. Bu doğrultuda çağdaş öğrenme yaklaşımlarının matematik başarısına etkisini inceleyen ve 2005–2014 yılları arasında yayınlanmış toplam 47 deneysel çalışma meta-analize dâhil edilmiştir. Bu araştırmalara katılan 2627 denekten elde edilen bulgulara göre çağdaş öğrenme yaklaşımlarının matematik başarısına etkisine ilişkin sentezlemeye gidilmiştir. Yayın yanlılığını test etmek amacıyla hesaplanan Orwin's Fail-Safe N sayısı 3956 olarak bulunmuştur. Dolayısıyla meta-analiz sonucunda bulunan 0.851 ortalama etki büyüklüğünün -0.01 düzeyine ulaşabilmesi için gerekli çalışma sayısı 3956 adettir (dahil edilen çalışma sayısının yaklaşık 84 katı). Meta-analize dâhil edilen 47 çalışma Türkiye'de araştırma sorusuna yönelik yapılmış tüm çalışmalardan (nitel, nicel, kuramsal vb.) dâhil edilme kriterine göre ulaşılabilmiş çalışmaların tamamıdır. Bunların dışında 3956 çalışmaya daha ulaşılması gerçekçi olmadığından, bu sonuç, bu meta analizde yayın yanlılığının olmadığının bir diğer göstergesi olarak kabul edilmiştir.

Rastgele etkiler modeline göre yapılan analizler sonucunda çağdaş öğrenme yaklaşımların matematik başarısı üzerindeki etkisinin anlamlı ($p< 0.001$) ve geniş ($d=0.93$) olduğu saptanmıştır. Bu değer çağdaş öğrenme yaklaşımlarının öğrencilerin matematik başarısını artırmada anlamlı düzeyde etkili olduğunu göstermektedir. Moderatör analizi sonuçlarına göre ise çoklu zekâ kuramına ($k=13$) göre işlenen derslerin matematik başarısı üzerindeki ortak etkisinin 0.978 ile geniş, işbirlikli öğrenme yaklaşımına ($k=16$) göre işlenen derslerin matematik başarısı üzerindeki etkisinin 0.724 ile orta-geniş arasında, PDÖ yaklaşımına ($k=9$) göre işlenen derslerin matematik başarısı üzerindeki etkisinin 0.941 ile geniş ve yapılandırmacı yaklaşıma ($k=9$) göre işlenen derslerin matematik başarısı üzerindeki etkisinin 1.290 ile geniş düzeyde olduğu görülmüştür. Çağdaş öğrenme yaklaşımlarının matematik dersi akademik başarısına etki düzeylerinin öğrenme yaklaşımına göre farklılık gösterip göstermediğini ortaya çıkarmak amacıyla rastgele etkiler modeline göre yapılan gruplar arası karşılaştırmaya göre uygulanan yaklaşımların matematik başarısı üzerindeki etkileri arasında istatistiksel açıdan anlamlı bir fark olmadığı ($Q_{GA}=6.456$, $sd=3$, $p=0.091$), bir başka ifadeyle çağdaş öğrenme yaklaşımlarının dördünün de benzer şekilde etkili olduğu görülmüştür. Bu çalışmada özellikle işbirlikli öğrenme yaklaşımı için elde edilen etki büyüklüğü, Batdı (2014), Şen& Yılmaz (2013), Tarım (2003) ve Çelik (2013) tarafından yapılan meta-analiz çalışmalarında bulunan geniş etki düzeyinden daha düşük olduğu ortaya çıkmıştır. Ayrıca çoklu zekâ, probleme dayalı ve yapılandırmacı yaklaşıma göre işlenen derslerin matematik akademik başarısı üzerindeki geniş etkisine dair bulgu, Çelik (2013) tarafından yapılan meta-analiz çalışmasının sonuçlarıyla tutarlılık göstermektedir.

Öğretim kademelerine için yapılan moderatör analizi sonuçlarına göre çağdaş öğrenme yaklaşımlarına göre işlenen matematik derslerinin akademik başarı üzerindeki ortak etkisinin ilkokul ($k=13$) kademesinde 0.673 (orta), ortaokul ($k=28$) kademesinde 1.034 (geniş) ve lise ($k=5$) öğretim kademesinde de 0.958 (geniş) düzeyinde olduğu görülmüştür. Çağdaş öğrenme yaklaşımlarının matematik dersi akademik başarısına etki düzeylerinin öğretim kademelerine göre farklılık gösterip göstermediğini incelemek için yapılan gruplar arası karşılaştırma sonucunda ilkokul, ortaokul ve liselerde yapılan çalışmaların etki büyüklükleri arasında istatistiksel açıdan anlamlı bir fark olmadığı görülmüştür ($Q_{GA}=4.136$, $sd=2$, $p=0.126$). Buradan hareketle çağdaş öğrenme yaklaşımı ile işlenen derslerin ilk, orta ve lise olmak üç temel eğitim kademesinde öğrencilerin matematik becerileriyle ilgili akademik başarılarına benzer şekilde olumlu bir katkı sağladığı sonucuna ulaşılabilir.

Meta-analize dâhil edilen çalışmalarda uygulanan çağdaş yaklaşımlarının etkilerinin deneysel müdahalenin süresinden (ders saati) ne yönde etkilendiğini ortaya koymak amacıyla yapılan meta-regresyon analizi sonucunda anlamlı bir etkiye rastlanmamıştır ($z= -0,04990$, $p>0.05$). Dolayısıyla bütün

çalışmalar için hesaplanan geniş etki büyüklüğü dikkate alındığında matematik derslerinde çağdaş öğretim yaklaşımlarını kullanmanın uygulama süresinden bağımsız olarak öğrenci başarısını olumlu yönde etkilediği sonucuna ulaşılmıştır.

Meta analize dâhil edilen çalışmalarda uygulanan çağdaş yaklaşımlarının etkilerinin deney grubunda yer alan kişi sayısına (grup büyüklüğü) göre ne yönde etkilendiğini ortaya koymak amacıyla yapılan meta-regresyon analizi sonucunda negatif yönde anlamlı bir etki saptanmıştır ($z=-2,12076$, $p< 0.05$). Hesaplanan regresyon katsayısı (-0,01624) grup sayısındaki bir birimlik azalışın çağdaş öğretim yöntemlerinin matematik başarısı üzerindeki etkisinde -0,01624 oranında bir artışa neden olduğunu göstermektedir. Buradan hareketle, dersteki öğrenci sayısı azaldıkça çağdaş öğrenme yaklaşımlarının matematik başarısı üzerindeki etkisinin arttığı sonucuna varılabilir.