A Meta-Analytic Study Concerning the Effect of Computer-Based Teaching on Academic Success in Turkey

Veli Batdı[a]

Kilis 7 Aralık University

Abstract

This research aims to investigate the effect of computer-based teaching (CBT) on students' academic success. The research used a meta-analytic method to reach a general conclusion by statistically calculating the results of a number of independent studies. In total, 78 studies (62 master's theses, 4 PhD theses, and 12 articles) concerning this issue were researched based on the literature review of the articles and theses which involved pre-test and post-test control groups and were conducted in Turkey between 2006 and 2014. The CMA and MetaWin statistical programs were used to calculate the effect sizes and variations for comparing the groups with regard to each study in the context of the meta-analysis. The effect size for the 78 studies was calculated as ES=1.13 based on analysis using the random effects model. This value is large, positive, and significant. Aside from this, the mean effect sizes of the CBT were large with regard to the independent variables such as grades level, subject area, types of course, implementation period, and publication year. As a result, it can be seen that the effect of CBT in terms of academic success was high and more successful than traditional teaching methods.

Keywords: Computer-based teaching • Academic success • Meta-analysis • Traditional methods • Students

a **Correspondence**
  Assist. Prof. Veli Batdı (PhD), Department of Educational Science, Faculty of Education, Kilis 7 Aralık University, Kilis 79000 Turkey
  Research areas: Curriculum and instruction; Foreign language teaching; Teacher training; Qualitative (NVIVO, MAXQDA) and quantitative (Meta-analysis, CMA, MetaWin, SPSS, Amos, Rasch Measurement Model); Research methods in education
  Email: veb_27@hotmail.com

It is known that a number of countries regard education as crucial for improving their current situation in every respect and moving it a step further in the information age of the 21st Century. In this context, the developments which have occurred in information technology have given students fast and easy access to information, which has made a great contribution to education systems (Aslan, 2006, p. 122). These developments have also enabled audio-visual aids such as animations and simulations to be used commonly in educational contexts. As a result of the applications of information and communication technologies in education systems, computer-based teaching (CBT) has emerged (Mayer & Moreno, 2002, p. 107; Serin, 2011, p. 183). CBT has been defined in a variety ways, such as educational contents or activities being conveyed through the computer (Hannafin & Peck, 1989 as cited in Güven & Sülün, 2012, p. 69) or benefitting from computer technologies to carry out educational activities such as presenting course contents, reinforcing what has been learned, or solving problems (Camnalbur, 2008, p. 9). According to Chojo, Anthony, Oghigian, and Uchibori (2012, p. 133) and Saminathan (2012, p. 166), CBT is a teaching and learning option that involves an educational dialogue between computer and student. However, the computer which is used to teach should be regarded as a complementary and supportive part of the educational process, not as an alternative to the teacher. Park and Hannafin (1993 as cited in Somyürek & Yalın, 2007) indicated that education systems are functional as long as they meet students' needs and individual diversities. In this regard, CBT generates techniques and methods with regard to individual diversities, inputs, and information processes by providing good opportunities during the teaching process and enabling a change of expectations in the context of learning (p. 588). Additionally, a number of studies (Abu-Seileek & Rabab'ah, 2007; Bakar, 2007; Cavalier & Klein, 1998; Lee, 2012) have confirmed that students' academic success has increased through the use of computers which provide rich content and visual-based applications. In this context, many studies have been conducted to increase academic success. However, İşman (2001, p. 21) stressed that many factors need to be taken into account, such as a school's financial situation, teachers' general characteristics, target behaviors, clear and specific program licenses, the most convenient placement of computers in laboratories in regard to windows, light, temperature, cleaning, and so on. Meta-analytical studies concerning CBT in the national and

international arena were examined and their results are also provided in this study. It was seen in the meta-analysis concerning computer-based teaching of foreign language by Tomakin and Yeşilyurt (2013) that foreign language teaching, which makes use of CBT, has a significant advantage. On the whole, the effect of technology on students' success turned out to be greater than expected in the meta-analytic study concerning the effect of the use of technology on the teaching and learning process in students' success by Cheung and Slavin (2011).

On the other hand, it was seen that there were significant differences between students who got their training thorough CBT and those who had not with regard to course acquisitions in some studies dealing with the effect of CBT on students' success (Kıyıcı & Yumuşak, 2005, p. 131). Buchanan (2000 as cited in Zhang, Duan, Fu, Wang, & Zhang, 2010) particularly stressed that the CBT approach had caused a change in teachers' and students' roles from traditional teaching and learning methods to being more active and individualistic. Lowe (2004, p. 53) got more successful results when he compared it to the traditional teaching approach. We understand that computers present rich content, enabling students to be more enthusiastic with learning, to practice more, and to retain more permanent learning (Young, 2003).

Recently, computer-based learning has been increasingly used in more and more studies that are conducted. AbuSeileek and Rabab'ah (2007, p. 59) suggested that computer-based learning enables students to learn by making self-assessment and self-reflection, providing them with immediate feedback and reinforcement, thereby making learning easy for them. From the results of the study, one can understand that CBT increases students' success by making the learning context more interesting and diversifying it with interesting game activities. The reason for this is that CBT gives a chance for every student to learn at their own pace, with their own techniques, and in one sense this individualizes the learning experience (Senemoğlu, 2003 as cited in Serin, 2011, p. 183). On the other hand, teachers in traditional teaching contexts are supposed to teach targeted subjects to a number of students who largely show differences with regard to personal aspects and academic levels. In this regard, however, some students understand subjects quickly and are bored the rest of the time while others are left behind and have to try to catch up to learn (Camnalbur, 2008, p. 15). To reach effective results with CBT, well-planned and developed computer programs, internet connections, clear and specific instructions, and teachers competent in the

use of computers are required (Bakar, 2007, p. 34). In addition to this, students are also required to have prior knowledge of computer use and must come to class well-prepared, because in one sense CBT depends on the students' integration of technologies with the instructional content (Barger & Byrd, 2011, p. 7). In this way, it can be thought that individual differences amongst students can be removed and they can learn well by taking precautions and being supplied with well-prepared computer programs.

As a result, commonly used items in the 19th Century such as chalk-boards and book-desks now seem to have been replaced with computer-based, learner-centered, research-based activities which are now currently required for the objectives of instructional programs (Roschelle, Pea, Hoadley, Gordin, & Mean, 2000, p. 76). As a result of the literature review, a number of meta-analytic studies with regard to CBT were examined in Turkey (Dinçer & Güçlü, 2013; Tekbıyık & Akdeniz, 2010; Tomakin & Yeşilyurt, 2013) and abroad (Akuka, Wambugu, & Anditi, 2013; Cheung & Slavin, 2011; Lai, 2014; Waxman, Lin, & Michko, 2003). In these studies, the effect of CBT on students' success has been positive. Therefore, this study was carried out to investigate to what extent CBT is effective for students' success with regard to several variables in Turkey such as grade level, subject area, course type, implementation period, and publication year.

The Purpose and Importance of the Research

This study aims to investigate the effect of CBT, an alternative to traditional teaching methods, on students' academic success by using the meta-analytic method. At this point, it can be stated that the role of computers in education is undeniable. Computer and touch-oriented technologies, such as smart tablets, are increasingly being used in education, based on the review of databases in Turkey and abroad in recent years (Burke, 2010; Lacina, 2009; Mechling, Gast, & Krupa, 2007; Türel, 2011; Yıldız & Tüfekçi, 2012). When computer-related studies are examined according to publication year, it can be seen that fewer studies have been conducted between 2012 and 2014 (Table 7). It is significant to discover that there hasn't been a study conducted in 2015 that includes the criteria of the current research, and an analysis of studies carried out in Turkey have not been made in terms of a moderator analysis. So an investigation was required to find out to what extent CBT is effective for students' academic success with regard to the variables of grade level, subject area, course type, implementation period, and publication year follow-

ing the integration of the computer into education. This study was conducted to contribute to the related literature by examining with regard to academic success the meta-analytic effect of computers, which have become a necessary part of the teaching process in the current era of changing technology.

Method

In this research, a meta-analytic method was used to calculate the effect size of CBT on academic success. This meta-analytic method, known as analysis of the analysis, was used to reach a general conclusion by statistically calculating the results of a number of independent studies (Glass, 1976, p. 3). Whitehead (2002 as cited in Küçükönder, 2007) defines meta-analysis as a holistic re-evaluation of the studies that have been conducted in different places and times by different people. With this method, the aim is to increase the reliability of results by expanding the sample size, shedding light for other researchers and predicting parameters by determining effect sizes. Apart from this, data has to be combined to create a common denominator of data after being retrieved from the research which has been conducted continuously (Şahin, 2005). Therefore, the role of meta-analysis in this research is to combine the data up to this point.

Population and Sampling

The population of this research consists of the articles and theses which were published in the context of CBT in Turkey and abroad. The sampling of the research is composed of the articles and theses which were permitted to be examined with regard to CBT in the databases of ProQuest dissertations and theses (PQDT), the Council of Higher Education National Thesis Center, Google Scholar, Ebscohost-Eric, Ebscohost-Professional Development Collection, Taylor and Francis Online Journals, and ScienceDirect between 2006 and 2014. The researcher did not use any sampling method as the aim is to reach the whole group of sampling in the research. 78 studies in total which met the criteria of the current research were included.

Data Collection

Theses and articles with regard to CBT which were conducted in Turkey were used in this study. The key words "computer-based instruction" and "computer-aided teaching" were searched both in Turkish and English in the related databases.

As the number of bulletins presented at scientific activities such as congresses and symposiums was insufficient, these studies were not analyzed. As a result of the literature review, 592 studies including 412 master's theses, 64 PhD theses, and 116 articles were examined. As some of these studies were not experimental, they were excluded from the research data. In conclusion, the necessary research was conducted and 78 studies which had been implemented with regard to the effect of CBT on academic success were included in the meta-analysis.

Criteria for the Inclusion of Studies

As a result of the literature review, studies were assessed as to whether they were appropriate for inclusion in this study based on the following criteria: the studies were conducted within the past eight years (2006-2014); the reported sample size (n), arithmetic mean (X), and standard deviation (sd) values of the experimental and control groups were used to calculate effect sizes; a CBT method and pretest-posttest control procedures were used; the effect of the related method on students' academic success was investigated; they were conducted in Turkey; and they were published both nationally and internationally. In other words, if the studies did not use a pretest and posttest control group model and were not eligible due to the above-mentioned criteria, they were excluded from the 592 studies. The sampling of the study consisted of 78 studies. Some studies were not included in the meta-analysis on account of being outside the margins of the present study: they had differences with regard to methodology, did not involve the necessary descriptive data for meta-analysis, were qualitative rather than quantitative, or were not appropriate for the criteria regarding the population or sampling size.

Encoding Method

A general coding was conducted to show all the characteristics of the studies involved in the meta-analysis to make comparisons. The coding method in this study was composed of two main headings and nine questions. In the first part "Study Identity" there were six questions and some information such as number and title of the study, names of the authors, the year and province of study, and so forth, which were provided for identifying the study. Three questions were involved in the section "Study Data." The sampling size for the experimental and control groups, and descriptive statistics such as means and standard deviations are given in this section.

Dependent Variables

The effect sizes of the studies involved in the meta-analysis with regard to the effect of CBT on academic success were accepted as dependent variables. Effect sizes were standardized values for different scales in each study (Bernard et al., 2004).

Study Characteristics

Independent variables in the meta-analysis were expressed as study characteristics and were coded to evaluate the relations between effect sizes and independent variables (Tarım, 2003). In this research, the study characteristics were to determine the effect of CBT with regard to the variables of grade level, subject area, course type, implementation period, and publication year, respectively.

Data Analysis

The studies in the meta-analysis were examined to determine effect sizes, and the findings regarding effect sizes were tested heterogeneously through right modeling. A moderator analysis (sub-group) was conducted to reach the heterogeneous source. Therefore, the chi-square heterogeneity test (Q statistics) with (k-1) degree of freedom as developed by Cochran (1992), which is the most common approach among heterogeneous tests, was used. Through this test, a null hypothesis for evaluating the same effect for all studies in the meta-analysis was assessed (Higgins, Thompson, Deeks, & Altman, 2003). The study-effect meta-analytic method was used for the statistical data analysis. The purpose of this was to calculate the mean differences, known as $d = (X_e \text{-} X_c)/SD$ in experimental studies, between the experimental and control groups (Hunter & Schmidt, 1990 as cited in Camnalbur & Erdoğan, 2008). Hedges' d was used for the calculation. This "d" value expresses the effect size and constitutes the basic structure of the meta-analysis. A random effects model (REM) was used to combine effect size values in the treatment effect. The distribution of the overall effect sizes with regard to the fixed effects model (FEM) was determined to be heterogeneous (Q = 563.09, df = 77, p < .05). In other words, REM was used as the effect-size variation for the study, which was higher than the change stemming from simple random error (Borenstein, Hedges, Higgins, & Rothstein, 2009; Dersimonian & Liard, 1986). The analyses were conducted according to REM because the distribution of the study was heterogeneous. In this way, the study aimed to remove illusions originating from the heterogeneous sampling (Demirel, 2005; Yıldız,

2002). Some classifications were made to interpret the importance of the effect sizes obtained from the meta-analytic results. This study was implemented using Cohen's (1992, p. 99) effect sizes classification. According to this classification, the values for effect sizes are as follows: *small,* between .20 and .50; *medium*, between .50 and .80; and *large,* over .80. Aside from this, the Comprehensive Meta Analysis (CMA) statistical program, MetaWin package program, and Microsoft Excel 2010 Office program were used to calculate the effect sizes for each study, to find variations, and to compare groups. The coding reliability value was determined for the reviewed studies by the assessors. For this purpose, the studies were examined by another reader of good academic background and with competency in a related field. The results were written into an article evaluation form. Later, the two readers' comments were compared and the consistency of the comments was examined. The reliability outcome was carried out according to the inter-rater reliability calculation formula (*consensus / (consensus + disagreement) x 100*) by Miles and Huberman (1994) and the reliability outcome was found to be 100%.

Findings

In this section of the paper, the findings related to the meta-analytic review on CBT were examined. Primarily, this is the descriptive information from the meta-analysis after which the calculated effect sizes are presented. Moreover, the researcher investigated whether there were any changes in the sub-categories. The following are the results of studies conducted in Turkey which considered the question as to whether there was any effect of CBT on the academic success of students compared to traditional methods, and if there was, to what extent or on which sub-themes did it have this effect. The level of significance in the study was determined to be 0.05; the significance levels of the studies included in the meta-analysis were also found to be 0.05. In the meta-analytic review, based on the results of the literature review, 62 MA theses, 4 PhD theses, and 12 articles were able to provide mean and standard deviation values concerning CBT. In total, 78 studies were examined concerning the effect of CBT on academic success. It can be identified that the experimental group included 2,648 students, while the control group included 2,636 after consideration of the studies as a whole.

In Table 1, grade level, subject area, publication type, implementation period, course type by grades level, and frequency and percentage values of the studies included in the meta-analysis were presented. When grade level is considered in Table 1, it is recognized that most of the studies were conducted in secondary schools (53.85%), then in universities (19.23%) and high schools (15.38%), while the fewest were in primary schools (11.54%). On the other hand, in terms of subject area, most of the studies

Table 1
Frequency and Percentage Values for Categorical Independent Variables of the Studies on the Effect of a CBT Method on Academic Success Scores

Variables	(f)	(%)	Variables	(f)	(%)
Grade Level			*Publication Type*		
Primary School	9	11.54%	MA/PhD Theses	62 / 4	79.49% / 5.13%
Secondary School	42	53.85%	Article	12	15.38%
High School	12	15.38%	Course types in primary, secondary, high schools and universities,		
University	15	19.23%			
Subject Area			*Course Type*	(f)	(%)
Science	32	41.02%	Science	8	10.26%
Mathematics	17	21.79%	Social Studies	7	8.97%
Social Sciences	13	16.67%	Science and Technology	14	17.95%
Foreign Language	1	1.28%	Mathematics	17	21.79%
Others*	15	19.23%	Physics	5	6.41%
Implementation Period (in weeks)			Turkish	3	3.85%
2 to 4 weeks	29	37.18%	*Course type for universities*		
5 to 6	13	16.67%			
7 to 8	3	3.85%	Chemistry	2	2.56%
9 to 18	10	12.82%	Biology	3	3.85%
Unspecified	15	19.23%	Physics	5	6.41%
ODCH **	8	10.26%	English	2	2.56%

*Including undergraduate lessons.
** The ones defined as course hours

were conducted in the field of science (32 studies at 41.02%), then mathematics (17 studies at 21.79%). In relation to the implementation period, most of the studies examining the academic success scores of students were in the two-to-four week period (78 studies at 37.18%), and the fewest were in the seven-to-eight week period (3.85%).

Table 1 shows the results of the studies in terms of publication type. The studies consisted of articles (15.38%), MA theses (79.49%), and PhD theses (5.13%). When the distribution of studies was analyzed with regard to the types of courses by grade level, it was observed that there were 17 studies in mathematics (21.79%), 14 in science and technology (17.95%), seven in social sciences (8.97%), and three in computer and information technologies (3.85%). These in particular were chosen for the study among the types of courses in primary schools, secondary schools, and high schools. Biology III (3.85%) and Physics III (6.41%) were also included in the meta-analysis as undergraduate courses. In addition, there were some courses not indicated in Table 1 but which contributed to the study. These were biology, chemistry, technical arts, geography, visual arts, and the History of the Revolution and Kemalism. Also for undergraduate courses there were computer hardware, arts education, and statistics classes.

Table 2 shows a 95% significance level from the Chi-square table with a critical value of 77 degrees of freedom at 98.49. As the distribution of X^2 with regard to 77 degrees of freedom with a Q statistical value exceeds the critical value ($X^2_{(0.95)} = 98.49$), the homogeneity of effect-size distribution was rejected according to the FEM. In other words, it was determined that the distribution of the effect size was heterogeneous. After the Q statistical value was seen as significant, it was thought that the variance of the study's effect sizes was larger than can be explained by sampling error (Özcan, 2008).

As the homogeneity test of the studies in the meta-analysis was higher than expected and was accepted as heterogeneous, the analyses were carried out in accordance with REM. In order to find out whether the reason for heterogeneity was due to a

sampling error or from having different variations due to sampling errors, studies were divided into groups and analyzed. Based on the analyses of the 78 studies included in the meta-analytic review, the standard error was .08 and the upper limit for 95% of the confidence interval was 1.29, while the lower limit was .97 and the effect size was 1.13. The effect size value was large according to Cohen's (1992) classification and accordingly it can be specified that using CBT had a positive effect on academic success.

The Efficiency of CBT Considering the Teaching Grades of Studies

The studies were divided into four different categories (primary schools, secondary schools, high schools, and universities) with a view to determine the effect of grade level in the samples on mean effect size. Analysis results in terms of these groups are presented in Table 3. When considering the effect of CBT on academic success with regard to grade level, the largest effect size was seen in secondary schools with a value of 1.31, while the lowest was in primary schools with a .66 value. The mean effect size for groups was .95. In other words, it was observed that all groups had large effect sizes except for primary schools (ES = Medium).

Table 3
Effect Sizes of Studies in Terms of Grade Level

School Level	N	ES	% 95 Confidence Interval		Level of ES
			Lower Limit	Upper Limit	
Primary	9	.66	.48	.85	Medium
Secondary	42	1.31	1.09	1.53	Large
High School	12	1.04	.57	1.50	Large
University	15	1.02	.61	1.43	Large
Total	78	.95	.83	1.08	Large

$Q_B = 19.60$, $Z = 14.44$, $df = 3$, ES: Effect Size.

The homogeneity test of the intergroup derived from the results of analysis in Table 3 indicates that the Q_B value was 19.60. The critical value from the $\chi2$ table at a 95% significance level and 3 degrees of freedom is 7.81 ($X^2_{(0.95)} = 7.81$). As the Q_B statistical value ($Q_B = 19.60$) with 3 degrees of freedom

Table 2
Homogeneity Values, Mean Effect Sizes, and Confidence Intervals in Effect Models of the Studies Included in the Meta-Analysis

Type of Model	N	Z	Q	ES	SE	95% Confidence Intervals	
						Lower Limit	Upper Limit
FEM	78	33.32	563.09	.99	.03	.93	1.05
REM	78	13.80	124.45	1.13	.08	.97	1.29

p_{FEM}: .00, p_{REM}: .00.

was greater than the critical value ($X^2_{(0.95)}$ = 7.81) of the X^2 distribution, the distribution of effect sizes in this collection of studies is considered heterogeneous. Thus, following the division of studies into groups in terms of grade level, the intergroup effect size (Q_B = 19.60; p < .05) showed that there was a significant difference among the groups.

The Efficiency of CBT Considering Subject Area of the Studies

For the purpose of determining the effect of subject area on the mean effect size, studies were divided into four different categories in terms of subject area: science (physics, chemistry, biology, science, science and technology, computers, and communication technologies), mathematics (math), social sciences (social studies, Turkish, geography, visual arts, and the History of the Revolution and Kemalism), and others (undergraduate courses: chemistry, biology, physics and computer hardware, arts education, statistics, and English). As only one study was found in the field of foreign languages at the grade level of secondary schools, it was not included in the analysis. Table 4 summarizes the outcomes of analysis regarding these groups. When the effect of CBT on academic success in respect to this subject area is taken into account, all subject areas including the mean effect size for the subject area were recognized as having a large effect size.

Table 4
Effect Sizes of Studies in Terms of Subject Area

Subject Area	N	ES	% 95 Confidence Interval		Level of ES
			Lower Limit	Upper Limit	
Science	32	1.14	.91	1.37	Large
Mathematics	17	1.06	.75	1.37	Large
Social Sciences	13	1.11	.70	1.51	Large
Others	15	1.02	.61	1.43	Large
Total	77	1.10	.94	1.25	Large

Q_B = .30, Z = 13.86, df = 3.

On the other hand, the intergroup homogeneity test value was seen as Q_B = .30 in Table 4. With a 95% significance level from the X^2 table and 3 degrees of freedom, the critical value was determined at 7.81 ($X^2_{(0.95)}$ = 7.81). Since the Q_B statistical value (Q_B = .30) with 3 degrees of freedom is smaller than the critical value of the X^2 distribution ($X^2_{(0.95)}$ = 7.81), the homogeneity hypothesis belonging to the distribution of effect sizes was accepted for FEM. Thus, when the studies in the analysis were categorized into groups with regard to subject area and their ef-

fect sizes were considered, no significant difference was found in terms of subject area (Z = 13.86; p > .05). In other words, academic success in the courses based on CBT did not show a change depending on subject area. Therefore, it can be stated that the method under consideration had a similarly considerable effect on all groups.

The Efficiency of CBT Considering Course Type in the Studies

The researcher primarily preferred to include the courses reached in a sufficient number of studies in order to view whether the effect size of the CBT diversified or not with regard to the type of course. A sufficient number of studies were conducted in elementary and secondary schools, and thus were divided into four different groups: science, social studies, science and technology, and mathematics. The analysis results of the types of courses as determined by the four groups are presented in Table 4. According to these results, the largest effect size was seen in social studies (1.54), while the lowest one was with mathematics (1.06). A general analysis for the effect sizes of studies by type of course demonstrated that in all types of courses, the mean effect size was ES = 1.19.

Table 5
Effect Sizes of Studies in Terms of Course *Type*

Courses	N	ES	% 95 Confidence Interval		Level of ES
			Lower Limit	Upper Limit	
Science	8	1.27	0.73	1.81	Large
Social Sciences	7	1.54	0.91	2.16	Large
Science and Technology	14	1.20	0.94	1.46	Large
Mathematics	17	1.06	0.75	1.37	Large
Total	46	1.19	1.01	1.37	Large

Q_B = 1.94, Z = 13.03, df = 3.

Table 5 summarizes the results of the analysis, with the Q statistical value being 1.938 following the homogeneity test. The critical value from the X^2 table at a 95% significance level with 3 degrees of freedom was calculated to be 7.81. In this calculation, as the critical value ($X^2_{(0.95)}$ = 7.81) was identified to be greater than the Q_B statistical value (Q_B = 1.94), the homogeneity hypothesis belonging to the distribution of effect sizes was admitted into FEM. In other words, the distribution seemed to be homogeneous. In addition, no significant difference was seen in terms of the intergroup effect sizes (Z = 13.03; p > .05) when considering the type of course. It can be inferred from this result that the

use of CBT on academic success did not indicate any change with regard to type of course.

The Efficiency of CBT Considering the Implementation Period

Studies were categorized into six different groups with regard to implementation period, such as two-to-four, five-to-six, seven-to-eight, or nine-to-eighteen weeks; unspecified periods; and those defined as "course hours" in order to determine whether the effect size of CBT had any differences in terms of the implementation period. Table 6 presents the analysis outcomes of these groups in detail. All groups were identified to have the same effect size (ES = large) when the study periods are examined in Table 6. The largest effect-size value was found for the nine-to-eighteen week period (*ES* = 1.87), but in the five-to-six and seven-to-eight week periods, the effect sizes were determined to be .97 and .93, respectively.

Table 6
Effect Sizes of Studies in terms of Implementation Period

| Implementation Period (Week) | N | ES | % 95 Confidence Interval | | Level of ES |
			Lower Limit	Upper Limit	
2-4	29	1.03	.78	1.29	Large
5-6	13	.97	.55	1.39	Large
7-8	3	.93	.59	1.27	Large
9-18	10	1.87	1.19	2.55	Large
Unspecified	15	1.09	.82	1.36	Large
ODCH	8	1.19	.51	1.86	Large
Total	78	1.07	.92	1.21	Large

$Q_B = 6.36$, $Z = 14.45$, $df = 5$.

In Table 6, the homogeneity test value for the groups in the meta-analysis appeared to be $Q_B = 6.36$. The critical value of the X^2 table at a 95% significance level with 5 degrees of freedom was 11.07. Since the Q_B statistical value in 5 degrees of freedom was smaller than the critical value of the X^2 distribution $(X^2_{(0.95)} = 11.07)$, homogeneity was seen amongst the effect sizes. In other words, the efficiency of CBT on the academic success of students had no significant difference in terms of implementation period (*Z* = 14.45, *p* > .05). The results show that no change was found in terms of the period the related method used in the courses for CBT. It can be stated, therefore, that this method had a similar considerable effect on all groups. Moreover, as there were a small number of studies in the seven-to-eight week period in accordance with the criteria, information about the current status was given instead of a definite conclusion.

The Efficiency of CBT Considering the Publication Year of Studies

In this section of the meta-analytic review, studies were split into four groups on account of their publication year, such as 2006 through 2007, 2008 through 2009, 2010 through 2011, and 2012 through 2014, to identify whether the effect size of CBT had any difference with regard to the publication year of the studies. According to the results presented in Table 7, the lowest effect size was seen in the 2006 through 2007 publication-year group (*ES* = .86). The effect sizes of the other groups were 1.10, 1.44, and 1.26, respectively, and the mean effect size was calculated at 1.12. Thus all effect sizes were recognized to be large.

Table 7
Effect Sizes of Studies in Terms of Publication Year

| Publication Year | N | ES | % 95 Confidence Interval | | Level of ES |
			Lower Limit	Upper Limit	
2006-2007	18	.86	.51	1.22	Large
2008-2009	37	1.10	.90	1.31	Large
2010-2011	15	1.44	1.05	1.83	Large
2012-2014	8	1.26	.74	1.78	Large
Total	78	1.12	.97	1.28	Large

$Q_B = 4.77$, $Z = 14.19$, $df = 3$.

The homogeneity test value of the intergroup achieved from the analysis of studies in terms of publication year was $Q_B = 4.77$. The critical value of the X^2 table at the 95% significance level with 3 degrees of freedom was 7.81. The homogeneity hypothesis belonging to the distribution of effect sizes was accepted into FEM for the Q_B statistical value ($Q_B = 4.77$) with 3 degrees of freedom, which was not greater than the critical value ($X^2_{(0.95)} = 7.81$) of the X^2 distribution. When the studies included in the meta-analysis were categorized in terms of publication year and their effect sizes were examined, no significant difference was discovered (*Z* = 14.19, *p* > .05). This result signifies that the academic success of courses based on CBT did not change in terms of publication year. In other words, using the computer-based method in learning environments had a similarly great effect on all groups in terms of publication year.

Publication Bias

One problem that may be encountered in meta-analytic reviews is the publication bias of studies included in the analyses. As the included studies focus on the question of statistical significance and published
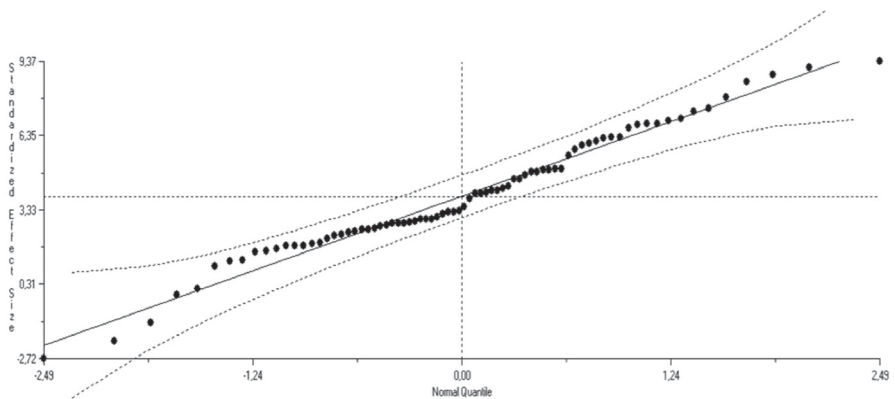
Figure 1: Normal quantile plot.

materials, a probability of publication bias may appear in these meta-analytic studies. Rosenthal (1979) suggested that unpublished null studies should be added in order to create a case of insignificant results. He referred to this as the fail-safe number (N_{FS}). The present paper had the N_{FS} value of 33,896.6 with regard to the effect of the CBT method on academic success. In other words, 33,896 studies were required with an effect size of zero to nullify the observed effect size of studies concerning the effect of CBT on academic success. The fact that it is not very likely to reach this number of studies means that the analytic results of the present study are reliable.

Figure 1 shows a chart of the Normal Quantile Plot using the MetaWin program. The intention was to see whether or not the effect sizes of studies were appropriate to the normal distribution, rather than their differences. Therefore, heterogeneity tests were carried out quantitatively and controlled with the visual chart.

The chart control by which the normal distribution can be viewed by using the MetaWin program indicated the reliability of the meta-analysis. If the general distribution of effect sizes was between the confidence interval identified along the line X = Y, the distribution was normal (Rosenberg, Adams, & Gurevitch, 2000). In Figure 1, any large deviations in the effect sizes were not encountered. In other words, the effect size distribution showed a normal function as it is between the two dashed lines. Therefore, it can be stated that there is a statistical relevance in the combination of studies included in the meta-analysis.

Discussion

The aim of this paper is to determine the effect of CBT on students' academic success. For this purpose, quantitative studies conducted from 2006 to 2014 regarding CBT were considered for this study. Related to this, 592 studies (MA theses, PhD theses, and articles) were identified. However, only those which were applied to the pretest-posttest control group model were chosen for the meta-analysis. Among the studies identified, a total of 78 studies (62 MA theses, 4 PhD theses, and 12 articles) were included in the meta-analysis based on the inclusion criteria, which also included being conducted in Turkey and published nationally and internationally.

When these 78 studies regarding the academic success of students were viewed in terms of grade level, subject area, implementation period, publication year, course type by grade level, and frequency and percentage values, most of the studies were seen to be at the secondary school level (53.85%) for grade level and in science (32 studies, 41.02%) when considering subject area. With regards to the implementation period, two to four weeks was the period over which most studies were conducted (37.18%). Moreover, most studies were MA theses (79.49%) as far as type of publication. On the other hand, with regard to the course area by grades level, among the course types in primary schools, secondary schools, and high schools, most studies were conducted in mathematics with 15 studies (21.79%).

The meta-analytic data of the 78 studies which consist of the academic success scores of students as based on the inclusion criteria and analyses of FEM indicate that the effect size was *ES* = .99 in favor of CBT. In accordance with the meta-analytic data of the 78 studies and analyses of REM, the standard error was 0.08 and the upper limit for 95% of the confidence interval was 1.29, while the lower limit was .97 and the mean effect size was *ES* = 1.13. This value is considered as large, positive, and significant according to Cohen's (1992) classification. Thus, it

can be stated that the efficiency of CBT on academic success was at a considerably high level.

The results mentioned above mean that CBT has a more successful outcome on students' academic achievement than is the case with traditional methods. This positive outcome showed consistency with other research in MA theses (Demir, 2004; Karaduman, 2008; Makaracı, 2004; Öz, 2004; Somuncuoğlu, 1996; Tankut, 2008; Taşkın, 2004), PhD theses (Balaban, 2002; Çalışkan, 1999; Hançer, 2005), articles in the national arena (Akuka et al., 2013; Çekbaş, Yakar, Yıldırım, & Savran, 2003; Güven & Sülün, 2012; Işık, 2007; Kıyıcı & Yumuşak, 2005; Teyfur, 2010), and studies conducted in the international arena (AbuSeileek & Rabab'ah, 2007; Ibrahim, 2011). This meta-analytic result, therefore, appears to be supported by the related literature.

In this meta-analytic review, it was intended to display the efficiency of the CBT method on academic success in terms of grade level, subject area, implementation period, publication type, and course type by grade level. Studies were analyzed in four categories (primary schools, secondary schools, high schools, and universities) so as to identify the influence of grade level over the effect size of studies in the meta-analytic research. The effect size by grade level was seen to have positive values, and while the largest value was observed for secondary schools (ES = 1.31), the lowest was for primary schools (ES = .66). It was recognized according to Cohen's (1992) classification that the efficiency level of CBT for all grade levels had a large effect size except for primary schools (ES = Medium). On the other hand, when the homogeneity test of the intergroup was considered, it was seen that the Q_B statistical value (19.60) was greater than the critical value ($X^2_{(0.95)}$ = 7.81) from the χ2 distribution with 3 degrees of freedom. Thus, the distribution of effect sizes in this collection of studies is heterogeneous. In other words, in terms of the division of studies into four groups of grade levels, there was a significant difference for the groups (Z = 14.44, p < .05). In a meta-analytic study conducted by Batdı (2014) on the effect of the Jigsaw technique upon students' academic performances, the results of the homogeneity test and effect sizes with regards to grade level emphasized that the technique under consideration has a positive effect.

With a view in determining the effect of subject area on the mean effect size, studies were divided into four categories: science, mathematics, social sciences, and "others." Following the analyses of the 78 studies in terms of subject area, it was seen that the largest effect size was seen with science (1.14), while the lowest

one was with "others", which included undergraduate courses (1.02). Moreover, the intergroup homogeneity test value was seen as Q_B = .30, and for Q_B statistical value (Q_B = .30) with 3 degrees of freedom when smaller than the critical value of the X² distribution ($χ2_{(0.95)}$ = 7.81), the homogeneity hypothesis relating to the distribution of effect sizes therefore becomes admitted into FEM. When considering the categorization of studies into groups with regard to subject area and their effect sizes, no significant difference was found in terms of subject area (Z = 13.86; p > .05). Correspondingly, in similar meta-analytic reviews of brain-based learning (Gözüyeşil, 2012- Q_B = 2.75; p > = .05) and the efficiency of conceptual change texts (Öner Armağan, 2011- Q_B = 3.07; p > .05), no significant difference was observed in the effect sizes in terms of subject area. On the other hand, in a meta-analytic study concerning CBT by Camnalbur (2008) conducted in Turkey, the effect sizes (Q_B = 22.07; p < .05) indicated that there was a significant difference among the groups.

In order to analyze the effect of studies upon the mean effect size and to compare the effect of CBT with regard to course type, the effect sizes were calculated. According to the results of analysis, a more successful outcome was witnessed in social studies than in science, science and technology, or mathematics as far as academic success. The largest effect size was seen in social studies with the value of 1.54, while the lowest was in the case of mathematics with a value of 1.06. Additionally, the intergroup homogeneity test value was seen to be Q_B = 1.94. As the critical value from the X² table in the 95% significance level with 3 degrees of freedom was calculated at 7.81, the critical value ($X^2_{(0.95)}$ = 7.81) was signified to be greater than Q_B statistical value (Q_B = 1.94). The homogeneity hypothesis relating to the distribution of effect sizes was, therefore, accepted in FEM. On the other hand, the effect of CBT on academic success did not have a significant difference in terms of the type of course (Z = 13.03; p > .05). It can be expressed from this result that the use of CBT on academic success did not indicate any change with regard to the type of course.

Studies were categorized into six groups in terms of implementation periods, two-to-four, five-to-six, seven-to-eight, and nine-to-eighteen week periods; unspecified periods; and those defined as 'course hours', with a view to clarify whether the effect size of CBT had any difference in terms of the implementation period. When the samples of 78 studies were analyzed in regard to implementation period, the largest effect size value was found for the nine-

to-eighteen week period (1.87), while the lowest was for the seven-to-eight week period (.93). These effect sizes were seen to be at large levels according to Cohen's (1992) classification. The intergroup homogeneity test in the meta-analysis indicated that the Q_B value was 6.36. In the event of the studies' categorization of implementation periods, it was considered that their effect sizes had no significant difference in terms of implementation period (Q_B = 6.36; $p > .05$). It can be inferred from this result that this method had a similar considerable effect on all groups. All the data can, therefore, be generalized to the whole sample size. In other words, generalization in relation to the effect size is affected by the size of working groups. Additionally, all other effect sizes belonging to implementation period except for the seven-to-eight week period had positive values. As the data for the seven-to-eight week period was obtained from only three comparisons, it was determined to not generalize the effect size of this period but to give information only about the current status. Rosenberg et al. (2000) stressed at this point that Hedges' d value which is used in the calculation of effect sizes can give reliable results in the case of at least five comparisons. The researcher suggests that more experimental studies in this subject area need to be conducted in Turkey and the world in order to generalize the results of analyses. In the meta-analytic study of Öner Armağan (2011), which concerned the efficiency of conceptual change texts, no significant difference was recorded in the effect sizes on account of the implementation period (Q_B = 2.36; $p > = .05$). It can be concluded, therefore, that the related result of the researcher's meta-analytic review shows a similarity with the present research result.

Studies included in the meta-analysis were split into four groups in terms of publication year (2006 through 2007, 2008 through 2009, 2010 through 2011, and 2012 through 2014) in order to identify whether the effect size of CBT had any differences with regard to the publication year of the studies. The results indicated that the lowest effect size was seen in the 2006-through-2007 publication group (ES = .86), while the largest was in the 2010-through-2011 group (ES = 1.44). Also, the mean effect size was calculated as 1.12. Thus, all the effect sizes were recognized to have large, positive, and significant effect sizes according to Cohen (1992).

From the homogeneity test value of the intergroup, the Q_B value was 4.77. In the case of categorization of studies in terms of publication year, it was seen that their effect sizes showed no significant difference (Q_B = 4.77; $p > .05$). This result demonstrated that CBT had a similarly great effect on all groups in terms of publication year. Gözüyeşil's (2012) meta-analytic review on the effect of brain-based learning upon academic success seems to therefore include parallel results (Q_B = .00; $p > .05$) with regard to this related sub-title.

In this meta-analytic study, it was intended to examine the effect of the CBT method on academic success in terms of grade level, subject area, course type, implementation period, and publication year. In general, it was recorded that the method under consideration had a considerable advantageous outcome on academic success. As a result of literature review in the national arena, although a sufficient number of studies on CBT were reached, it is suggested that researchers in the future should examine more PhD theses. However, the present paper examined the effect of CBT only on academic success. Therefore, the researcher suggests that further meta-analytic studies review the effect of CBT on other variables such as attitude, retention, and success. Lastly, the studies on CBT, especially in high schools, have experienced a decline lately because of an increased use of touch-based technological devices in these grade levels. In order to demonstrate this area in detail, the effect of these devices on academic success could be examined through further meta-analytic reviews.

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