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Review Article

A Meta-Analysis on the Effect of Context-Based Learning on Students' Science Academic Achievement in the Turkish Education System

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Abstract

In this study, the effect of context-based learning (CBL) on Turkish students' science academic achievement was calculated using the meta-analysis method. The Comprehensive Meta-Analysis (CMA) 2.0 program was used to calculate the effect size. The effect size of the CBL on the achievement of the students was determined to be 0.928 and this result is interpreted as "large level" in the relevant literature (Cohen 1988; Thalheimer & Cook, 2002). It was determined that the effect of context-based learning on students' science academic achievement was $p<0.05$. According to all the results obtained within the scope of the research, it can be said that CBL has a significant effect on Turkish students' science academic achievement. As a result of the statistical calculations made within the scope of the research, it was concluded that context-based learning did not make a significant difference on the academic achievement of students in terms of teaching level and science field.

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Introduction

In a developing and changing world, it is of great importance for individuals to follow the developments and keep up with the age. Human kind needs technology to facilitate their lives and to find an easier and faster solution in the case of events. Both social and individual aims of educational activities are to make sense of technology against the problems or situations encountered in daily life and to try to use these activities at the highest level. Considering the science curriculum, the vision of the science course is to raise all individuals as science literate (Ministry of National Education [MoNE], 2018). In this context, it is extremely important to raise individuals with 21st century skills-critical thinking, producing, using what they produce, researching and questioning. As a matter of fact, science is of great importance in raising scientifically literate individuals with the support of scientific and technological developments (Saraç & Özarslan, 2017). With the

technological developments in the world, the expressions of science, technology and scientific literacy have gained importance and the education curricula in most countries have begun to be revised according to these developments (Derman, 2014; Kaya & Elster, 2019). The purpose of the science is to understand nature, make sense of technology, relate to the environment, direct scientific research and comprehend how these researches are done, rather than just teaching subjects and/or concepts (MoNE, 2004).

By adopting a constructivist approach in the contemporary education system, it is aimed for individuals to construct information by making sense of it in a whole and accessing information by themselves rather than learning by memorizing information (Bakır, 2018). With the constructivist learning approach, it is ensured that students are able to research, question, use information in their daily lives, be genuine and initiative (Saysal-Araz, 2013). The educational understanding in recent years is based on the individual's ability to make sense of knowledge and turn it into experience rather than the level of knowledge the individual has (Dağlı, 2021).

Science courses provide students with the opportunity to benefit from technology, to produce solutions to the problems they may encounter in daily life and to enable them to grow as qualified citizens (Yiğit, Devecioğlu & Ayvacı, 2002). In the constructivist approach adopted with the renewal of the curriculum, students are expected to associate the facts and concepts they learn with daily life. It has been determined that if the information learned is transferred, it can become meaningful and permanent (Ayas & Özmen, 1998). When we look at the studies, students' associating the information they have learned with daily life reveals how permanent the science concepts learned are (Pınarbaşı, Doymuş, Canpolat & Bayrakçeken, 1998).

With the adoption of the constructivist approach, there have been changes in the teaching, methods and techniques used in courses. One of these techniques is context-based learning (CBL). CBL is a learning and teaching technique that enables the transfer of knowledge by associating the subject covered by the teacher with daily life. CBL has been widely used to improve the quality of education (Tulum, 2019). CBL supports students to learn by doing and experiencing as well as making the information learned more permanent (Ültay & Çalık, 2011). After teaching concepts and/or subjects with a traditional learning approach, examples from daily life are given. In context-based learning, unlike the

traditional approach, daily life events are at the beginning of this process in learning subjects and/or concepts (Güneş-Koç, 2013; Ünal, 2008).

The quality of the science course will contribute to the progress of our country in the field of science and technology. In addition, the science course consists of subjects that the individual can encounter in his/her daily life and the qualified execution of this course enables the individual to make sense of life (İnci, 2019). In addition to concrete concepts, abstract concepts are also included in the science course. In the traditional approach, giving more place to memorization and less to activities and the fact that theoretical knowledge is at the forefront reveals the importance of context-based learning more. However, in the CBL, students can establish the connection between theoretical knowledge and practice, which makes the knowledge more meaningful and permanent (Kutu, 2011; Reid, 2000). Therefore, the more the student makes sense of the information and makes it permanent, both the attitude towards the course, motivation and academic achievement will be affected at this rate. Context-based learning enables concrete and abstract concepts to be learned more meaningfully. In this learning process, it becomes easier for students to find answers to their questions they constantly ask: "why am I learning?" and "what will this do for me?" (Kutu, 2011).

Problem Situation

Science is a discipline that is very difficult to be fully understood by both students and teachers because it usually contains abstract concepts (Güneş-Koç, 2013). Learning basic science concepts has a very important place in learning subsequent complex concepts. As a matter of fact, studies conducted by Sarıkaya (2007) revealed that even prospective teachers have misconceptions about the concept of atom, which is a basic concept. It is known that the understanding of the world and the universe in science has a very important place in terms of recognizing nature and life. The information learned will be more permanent and meaningful when it is understood what the relationship between the concepts and / or subjects that are aimed to be taught within the scope of the science lesson is with daily life. In addition, both cognitively and affective students will be affected by this situation.

Based on all these, this study examined the effect of CBL on cognitive domain. In addition, statistical analyses of science learning domain and level of education as moderators were also examined. Concrete and abstract thinking levels in individuals differ developmentally (De Jong, 2008). Therefore, the effect of CBL in primary, middle and high

school education levels and the effect of CBL according to learning areas have been a matter of curiosity. It is a fact that the number of scientific studies is increasing day by day. Although it is accepted that the studies are comprehensive in themselves, studies may have limitations such as sample numbers, application contents and time to generate the final report. Due to these limitations, the results of individual studies may be similar or different from each other (Okur & Koca-Akkuş, 2021). However, pooling and synthesizing these research findings will help to reach a common conclusion and generalize this result. Therefore, meta-analysis studies gain importance. Meta-analysis studies provide a consistent process for gathering and interpreting the results of independent studies (Cohen, Manion & Morrison, 2007).

When we look at the studies, the fact that the studies have an effect on the group to which they are applied is fixed, but still, an idea is obtained through meta-analysis as to whether this application is meaningful in the general framework (Dinçer, 2014). When meta-analysis studies are examined, it presents the reasons for these effects as well as the extent of the effect of the practice or study. In addition, it provides us with a more understandable and clear summary of many large and scattered information. Meta-analysis studies make it possible to see the change of these studies according to years (Köymen & Şahin, 2004). In line with this goal, in meta-analyses, firstly, the effect degrees are calculated for each study examined in accordance with predetermined criteria, and the results of all studies are evaluated in accordance with common criteria. With a more theoretical definition, meta-analysis is to explain the effect of the independent variable on the dependent variable with the effect size coefficient by using quantitative data belonging to previous studies on a particular subject (Dinçer, 2018).

In present study, researches investigating "the effect of CBL on students' achievement in science" conducted between 2008 and 2022 were brought together and the effect size was calculated. In the Turkish education system, the constructivist learning approach has been taken as a basis in the curriculum of primary education institutions since 2005 and secondary education institutions since 2006. Since the academic studies on context-based learning in Turkey, which were examined within the scope of the study, contributed to the literature as of 2008, 2008 was taken as the starting year in this research.

Purpose and Importance of the Study

While students are trying to learn many concepts, topics and/or events in their related courses, they often wonder: Why do I need to learn and will the learned information be useful to me outside of school? (Tulum, 2019). Associating the subjects with daily life has an important place in terms of understanding the science course. CBL is one of the methods (multiple intelligence theory, problem-based learning, research-based learning, argumentation method) used in associating subjects with daily life. In the context-based learning approach, it is argued that learning takes place through contexts such as daily life stories, real-life events, and technological tools. Therefore, learning takes place more easily, meaningfully and permanently in natural environments (MoNE, 2009). With this learning approach, it is aimed to increase the success of students, to reconcile the learned subjects with daily life, to train individuals who research more, question and transfer the knowledge they have learned to their daily lives (Güneş-Koç, 2013). If students can associate a concept and its practices with the real world, including their own culture, family or friends, it is stated that effective learning takes place (Ayvacı, 2010).

While context-based learning is so important in terms of science courses, it is seen that there are not enough studies when the studies are examined. With the context-based learning approach-based teaching programs implemented since the 2008-2009 academic year (Hırça, 2012), the course topics have been structured to facilitate students' understanding by making them more up-to-date and entertaining (Topuz, Gençer, Bacanak & Karamustafaoğlu, 2013). In the present study, the effect of CBL in science education on students' achievement in science was tried to be revealed by using Meta-Analysis method. In this study, national studies on the subject (written in Turkish and English) were compiled and it was investigated whether CBL has an effect on students' achievement in science. It is thought that the studies conducted in this research will contribute to the literature by bringing together the studies with the meta-analysis method.

Method

Literature Search Strategy

There are steps to be followed in order to carry out a meta-analysis study. A problem situation is identified and a literature review is conducted on this problem. All studies based on the problem are coded according to predetermined criteria. Then, the results are obtained by statistical analysis of the studies (Pigott, 2012). The first step to provide a systematic

literature review is to determine the academic databases in which the research will be conducted (Ritzhaupt, et al., 2021). After selecting academic databases covering a wide variety of disciplines that publish educational research, the process followed to collect the necessary data was determined (TRDizin, SOBIAD, OAJI, ROAD, ERIC (Education Resources Information Center), DRJI, ASOS Index, DOAJ, published and unpublished theses in the database of the National Thesis Center of the Council of Higher Education (CoHE)). The scanned academic studies were selected according to the key terms suitable for the purpose of the study within the framework of "context-based learning".

The second step in the process of screening these studies was identifying the key terms required. Within the scope of the study, the following combinations were determined for the search (key) terms: context-based learning (context, contextualization, contextual) AND academic achievement (science achievement, achievement, student achievement) AND student achievement (student, learner, middle school student, high school student, primary school student) AND science course (science, chemistry, physics, biology).

Inclusion and Exclusion Criteria

The following criteria were taken into account in the inclusion of the scanned studies: (1) Studies must have been published between 2008-2022, (2) The studies were selected from the published and unpublished theses of CoHE Thesis Center, (3) In order to measure the standardized effect size in meta-analysis studies, the studies included in the research must have control-experimental groups. These studies should be using the teaching method foreseen in the Science course curriculum in the Turkish Education System in the control groups, and the studies using the context-based learning method in the experimental groups. (4) In order to determine the effect size of the meta-analysis study, numerical data of the experimental and control groups of the studies included in the study are needed. For this reason, studies in which the sample size, mean value and standard deviation value of the experimental group and control groups were known could be included. (5) Since the studies to be used in the research should be used in science lessons, attention was paid to the fact that they were studies conducted at primary, secondary and high school education levels. (6) The studies to be included in the study should measure the effect of the courses taught with the context-based learning method on academic achievement with quantitative data and finally (7) The fact that the studies took place in Turkey and that the language of writing is Turkish and English are among the inclusion criteria. Some of the studies were not included

in the analysis because they were not experimental studies and some did not contain sufficient data to analyze. In this context, 23 studies belonging to the academic achievement variable were included in the analysis.

Some of the studies were not included in the analysis because they were not experimental studies and some did not contain sufficient data to analyze. In this context, 23 studies related to academic achievement variable, 19 studies related to attitude variable and 11 studies related to motivation variable were included in the analysis. When the relevant literature was examined for the meta-analysis study, a total of 29 studies examining academic achievement in science were found. After examining the studies, some researches were not included in the research. The characteristics of the researches not included in the research are as follows: Yıldırım and Gültekin (2017) were not included in the study because there was no control group in their study, Ekinci (2010) was not included in the study because there was no standard deviation value for the intervention and control groups, Çekiç-Toroslu (2011) was not included in the study since there was no posttest standard deviation value for the intervention and control groups, İnci (2019) was not included in the study because there was no control group in his study, Köroğlu-Ergel (2021) was not included in the study because there was no control group and Gül (2016) was not included in the study because there was no control group.

Data Coding

According to Okursoy-Günhan (2009), there should be a coding system that will transform the criteria of the research into continuous/categorical variables in Meta-Analysis studies. The coding form to be used for this purpose consists of three parts. In the first section, there are four basic questions indicating the identity of the study. In this section, the name of the study, the year, the author(s), the geographical region where the study was conducted, and the total sample size are available. The second part includes 5 questions. The questions in the second part provide information about the characteristics of the research. The third section contains the statistical data of the research. The coding form used in this study was used by reorganizing the coding forms used by Camnalbur (2008), Okursoy-Günhan (2009) and Armağan (2011).

Data Analysis and Interpretation

In this study, the study effect was used from the group difference Meta-Analysis, which is used when the arithmetic averages of the dependent variables of the studies that

meet the inclusion criteria are not obtained from the same scale (Cohen, 1988). In the Meta-Analysis method, it is aimed to reveal the difference between the means of the intervention and control groups in the experimental studies with the formula [d= (Xe – Xc / SD)] (Hunter & Schmidt, 1990). The "d" value that emerges after the calculations is the symbol of the effect size. Effect size, which is the basic term of Meta-Analysis, explains the magnitude and frequency of the phenomenon in the society. After categorizing according to the data obtained from the study, Fixed and Random Effect Size models were used and then analysis effect sizes were calculated. In the literature, Cohen's (1988) classification and Thalheimer and Cook's (2002) effect size classification are used to comment on the effect size values calculated during the meta-analysis process. Thalheimer and Cook (2002) classification was used in this research because it includes a more detailed classification. The classification data are given in Table 1.

Table 1. The effect size classification by Cohen (1988) and Thalheimer and Cook (2002)

Cohen (1988) classification	**Thalheimer and Cook (2002) classification**
0.20 < Effect Degree < 0.49 → Low Level	-0.15 ≤ Effect Degree < 0.15 →Insignificant Level 0.15 ≤ …….. < 0.40 →Low Level
0.50 < ……< 0.79 → Moderate Level	0.40 ≤ …… < 0.75 → Moderate Level 0.75 ≤ …….. < 1.10 → Large Level
0.80 ≤ ……. → Large Level	1.10 ≤ …… < 1.45 → Very Large Level

In the study, the CMA 2.0 program was used to calculate the publication bias and the funnel scatter plot was examined. The X-axis of the graph gives information about the effect size of the study, and the Y-axis about the standard error. In the funnel plot, if the studies are located in the inner and end parts of the funnel, it means that the effect size value is high. For each study in the forest graph, the rectangles opposite indicate the effect size of the studies. Long lines provide information about the 95% confidence interval (Üstün & Eryılmaz, 2014). If the diamond-shaped value in the graph exceeds the 0 (zero) line, it is concluded that there is no significant difference between the intervention and control groups, and if it does not exceed the line, there is a significant difference between the intervention and control groups (Ried, 2006). The horizontal line shows the confidence interval. If the line crosses the 0 (zero) line, the diamond shape, which expresses the overall effect size, should not intersect with the 0 (zero) line in order to state that the study is statistically significant and the study is statistically significant (Bakioğlu & Göktaş, 2018).

Findings

In this context, there are a total of 23 researches included in the study. In all 23 researches of the academic achievement variable included in the Meta-Analysis study, the number of intervention group samples is 796 and the number of control group samples is 762. The frequency/percentage statistics of the studies that meet the inclusion criteria as a result of the literature review of the Meta-Analysis study according to the type of publication, study year and education level are shown in Table 2.

Table 2. Distribution of researches by publication type, year of the study and education level

Year of the Study	Frequency	Percent (%)	Grade Level	Frequency	Percent (%)	Publication Type	Frequency	Percent (%)	Field of Science	Frequency	Percent (%)
2008	1	4.3	5th Grade	2	8.6	PhD	8	34.7	Physics	5	21.7
2012	1	4.3	6th Grade	4	17.3	Master	12	52.17	Chemistry	13	56.5
2013	2	8.6	7th Grade	4	17.3	Article	3	13.04	Biology	5	21.7
2014	1	4.3	8th Grade	3	13.04						
2016	4	17.3	9th Grade	4	17.3						
2017	3	13.04	10th Grade	5	21.7						
2018	3	13.04	11th Grade	1	4.3						
2019	5	21.7									
2020	1	4.3									
2021	2	8.6									
Total	23	100	**Total**	23	100	**Total**	23	100	**Total**	23	100

According to Table 2, it was seen that the most studies were conducted in 2019, in which 12 studies were conducted from the master's degree type, and according to the distribution according to the level of education, the most studies were at the secondary school level. When the studies were examined according to the academic achievement variable, it was seen that the majority of the studies were on Chemistry subjects with a rate of 56.5%.

The publication bias is considered firstly. In the graph showing the publication bias, the region outside the funnel provides characteristics about the publication bias. The horizontal (x) axis in the graph gives information about the effect size and the vertical (y) axis gives information about the sample size/variance. There is a line in the graph that divides the funnel-shaped region symmetrically. This line shows the overall effect size. Studies are expected to be symmetrical within the funnel plot and also centered around the

overall effect size line. For this reason, it is important for the reliability of the study that the majority of the studies are within the funnel. Accordingly, publication bias graphs and statistics are given below.

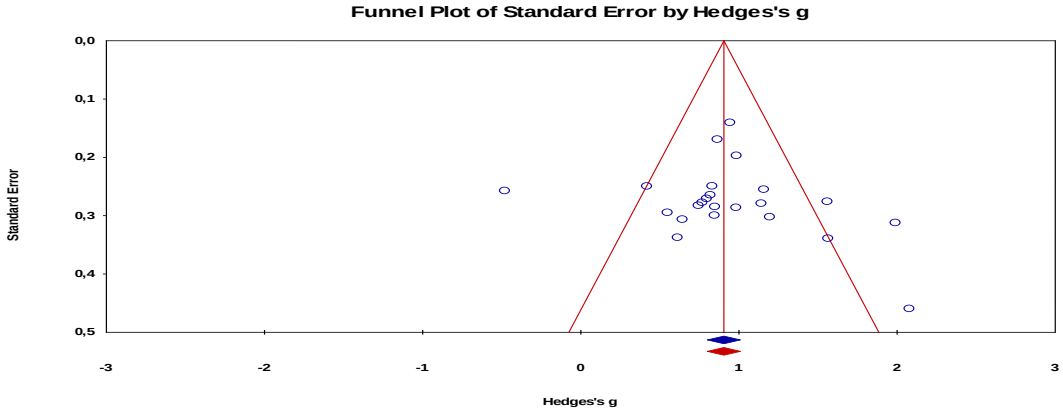

Figure 1. Academic achievement publication bias funnel plot

The graph in Figure 1 shows that there are 4 studies left outside the funnel. Studies outside the funnel constitute 17.39% of the research. However, the fact that the studies outside the funnel are not far from the funnel plot shows that publication bias may be insignificant. The publication bias of the related studies was determined by the statistical values of Classic Fail-Safe N and Kendall, and the results are shown in Table 3.

Table 3. Publication bias classic fail-safe N and Kendall's statistics

The Power of Meta-analysis		**Bias Status**	
Z Value	16.7627	Kendall's (P-Q)	31
P Value	0.0000	Kendall's Tau	0.12253
Alpha Value	0.05	Z-Value for Tau	0.81878
Z-Value for Alpha	1.95956	Kendall's p	0.20647
Number of missing studies required for *p*>alpha result	1660		

According to Table 3, 1660 researches should be added to the analysis in order for the effect size of 23 researches included in the studies to be close to zero. This result tells us that in order for the data of this research to be considered invalid, 1660 studies from the literature should be added in the opposite direction of these data. According to the literature review of the study, it can be said that there is no publication bias in the Meta-Analysis since it was not possible to reach the specified number of researches. First of all, the heterogeneity test of the study was performed and the results are shown in Figure 2.

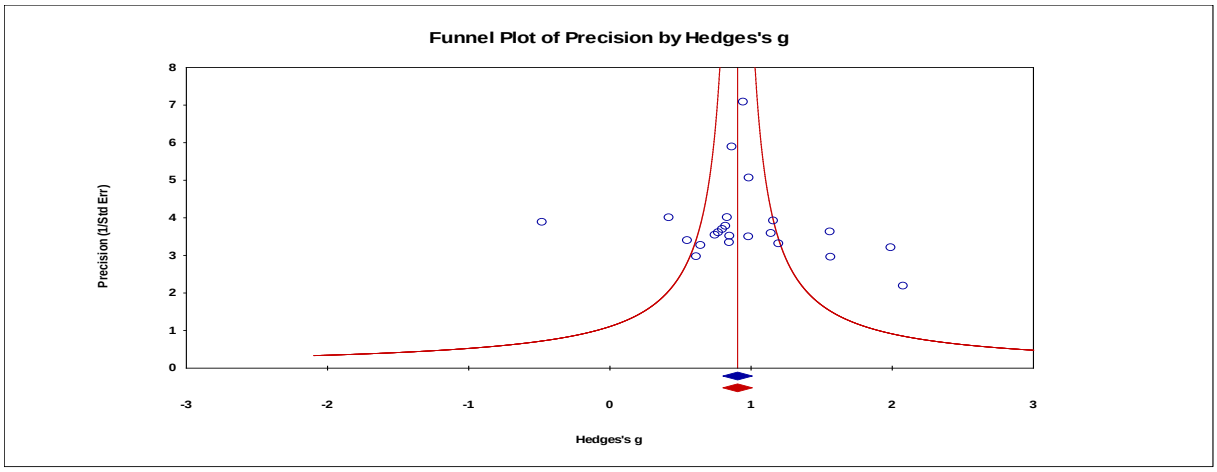

Figure 2. Funnel plot of effect sizes by Hedges's g value

According to Figure 2, almost all individual studies are expected to be included in the funnel. In the graph, the distribution of the studies outside the funnel shows that the frequencies of these researches show a heterogeneous distribution, but this is not an adequate result. Therefore, it is necessary to test the heterogeneity of the related researches (Dinçer, 2014) by looking at the values by "Q" or "p" and the relevant results are shown in Table 4.

Table 4. Heterogeneity test results of studies examining academic achievement heterogeneity tau-squared

Heterogeneity				Tau- Squared			
Q	**df**	***p***	**I2**	**Tau-squared**	**Standard Error**	**Variance**	**Tau**
67.179	22	0.000	67.252	0.137	0.066	0.004	0.370

It was observed in the Table 4 that the Q statistical value (67.179) exceeded the critical value determined in the chi-square distribution with (22) degrees of freedom. This result shows that the distribution of the effect size of the study is “heterogeneous”. In the relevant literature, it is considered appropriate to use the random effects model for model selection in heterogeneous studies (Akgöz, Ercan & Kan, 2004; Borenstein, Hedges, Higgins & Rothstein, 2013).

The effect sizes were determined for both models of the study and the results are given in Table 5. According to the results obtained, it was decided that the Random Effects Model was the appropriate model for this study (Lipsey & Wilson, 2001).

Table 5. Combined effect sizes of academic achievement for the meta-analysis study

Model	Effect Size	Standard Error	Variance	95% Confidence Interval		*p*
				Lower Limit	Upper Limit	
Fixed Effects	0.924	0.053	0.003	0.800	1.000	0.000
Random Effects	0.928	0.096	0.009	0.739	1.117	0.000

According to Table 5, the effect size was determined as 0.928. This value is explained as "large level" according to both classification types. The results show that CBL has a great effect on students' achievement in science ($p<0.05$). The forest graph showing the individual effect sizes and the overall distribution of the overall effect size and study weights of the studies examining the achievement in science education according to CBL is shown in Figure 3.

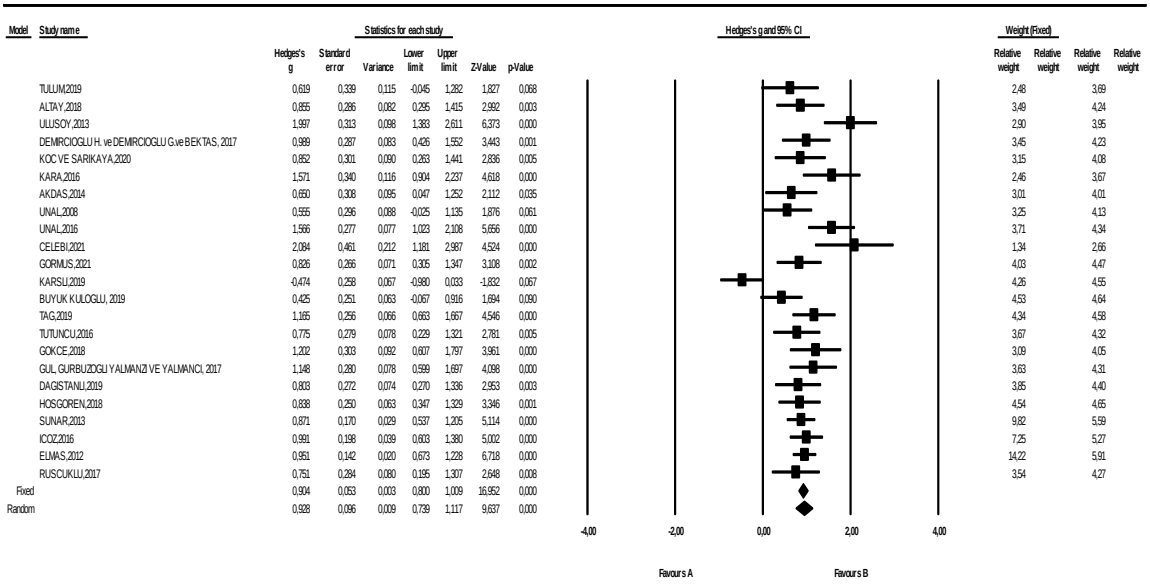

Figure 3. Distribution of effect sizes according to Hedges's g value for studies examining academic achievement - forest graph - study weight

It can be said that the individual effect size of the studies is positive with 22 of the 23 studies. While 95.62% of the studies are positive, 4.3% of them show a negative result. According to the results obtained, since most of the studies gave positive results, it was determined that conducting the courses according to CBL was more effective on the academic achievement variable. The effect sizes of the researches were interpreted according to both classification types. Cohen (1988) effect size classification is given in Table 6.

Table 6. Cohen (1988) effect size classification

Classification Level	**Frequency**	**Percent**
Insignificant	1	4.34%
Low	1	4.34%
Moderate	5	21.73%
Large	16	69.56%
Total	23	100

According to the Cohen (1988) classification, it is seen that the effect sizes of the 16 researches participating in this research are "large". Studies with a large effect size constitute 63.56% of this study. For a more detailed classification, Thalheimer and Cook (2002) classification was made and the results are shown in Table 7.

Table 7. Thalheimer and Cook (2002) classification of effect size

Classification Level	Frequency	Percent
Insignificant	0	0%
Small	2	9.09%
Medium	3	13.63%
Large	11	50%
Very Large	1	4.54%
Excellent	6	27.27%
Total	22	100

In the Table 7, the effect size (-0.474) values of one study (Karslı-Baydere & Akın-Yanmaz, 2019) were not included in the table because they were outside the ranges. It is seen that 50% of the study has a large effect size. When the effect size frequency of the study is considered, it can be said that it is positive in favor of CBL.

In the research, "Is there a difference between the effect sizes of the CBL in terms of academic achievement when determined according to the science course fields (Physics - Chemistry - Biology)?" sub-problem was also investigated and effect sizes were calculated in both models. The effectiveness was examined by comparative effect size values. A heterogeneity test was conducted to decide which statistical model to choose in order to calculate and interpret the overall effect size for the effect of science areas on achievement. The results are shown in Table 8.

Table 8. Heterogeneity test of science field moderator according to academic achievement

Science Fields	N	Standard Error	Q	df	*p*	I2	General Effect Size	Lower Limit	Upper Limit
Physics	5	0.608	32.271	5	0.000	87.605	0.608	0.332	0.885
Chemistry	13	0.940	22.821	12	0.029	47.417	0.940	0.812	1.067
Biology	5	0.125	6.706	5	0.152	40.353	1.007	0.762	1.252
Total within (Fixed Effects Model)			61.798	20	0.000				
Total between (Mixed Effects Model)			0.203	2	0.904		0.960	0.804	1.116

When the heterogeneity test results according to the science fields of the study were determined, the fixed effects model was investigated first and the significance level of the within-group heterogeneity test in this model was calculated. In addition, the heterogeneity

test Q statistical value of the research was determined as 61.798 and the degree of freedom was as 20. The critical value of the χ^2 table at the 95% significance level is 31.410. The calculated Q statistical value of 61.798 and 20 degrees of freedom exceeded the critical value calculated in the chi-square distribution. Based on these results, it can be said that the studies have the same widespread effect within themselves/the studies have a higher distribution than expected.

With these results, the *p* value was determined for the between-group heterogeneity test according to the Mixed Effects Model. The significance level of the test was calculated as (p=0.904)>(p=0.05). In addition, the Q statistical value of the study was determined as 0.203 and the degree of freedom was 2. In the χ^2 table, the critical value at 95% significance level is 5.991. It was determined that the calculated Q statistical value was below the critical value in the chi-square distribution. Based on these results, it was concluded that the effect sizes of the students' science course academic achievement of CBL did not show a significant difference according to the science fields. The effect sizes of all studies in the research investigating the effect of science fields on achievement were examined according to Hedges's g value, and the Forest Chart, which expresses the general distribution of the effect sizes, is as in Figure 3.

Another sub-problem investigated in the study, "The degree of effectiveness of CBL in science education on the achievement of students in terms of teaching levels" was determined by comparative effect size values. Since there was no study conducted in primary school, it was not included in the table.

In the analyzes, effect sizes were calculated according to both models. A heterogeneity test was conducted to determine which statistical model to choose in order to be able to interpret the overall effect size for the effect of teaching levels on academic achievement. The results of the test are given in Table 9.

Table 9. Heterogeneity test of teaching level moderator by academic achievement

Grade Level	N	Standard Error	Q	df	*p*	I2	General Effect Size	Lower Limit	Upper Limit
Secondary School	13	0.081	44.110	12	0.000	72.796	0.750	0.592	0.908
High School	10	0.071	16.493	9	0.057	45.431	0.025	0.886	1.165
Total Within (Fixed Effects Model)			60.603	21	0.000				
Total Between (Mixed Effects Model)			1.770	1	0.183		0.985	0.818	1.151

When the heterogeneity status of the category of education levels is analyzed according to the heterogeneity test results, the p value for high school level is calculated as 0.057 (p>0.05). At the same time, the statistical value of high school level Q is below the critical value of χ^2 table at 95% significance level. Therefore, fixed effect model was selected for the groups. The significance level of the heterogeneity test for secondary school level was calculated as p<0.05. When the heterogeneity test Q value of the study was investigated, it was concluded that the studies were heterogeneous because it was above the critical value. Therefore, random effects model was selected for this level of education.

In the study were examined, the fixed effects model was investigated first. The significance level of the heterogeneity test for the group in the fixed effects model was determined as (p<0.05). In the heterogeneity test Q statistical value of the study was determined as 60.603, and the degree of freedom was as 21. The critical value of the χ^2 table at the 95% significance level is 20.337. It was determined that the determined Q value exceeded the critical value with 21 degrees of freedom. Based on all these findings, it can be said that the researches have the same widespread effect within themselves or that the studies have a higher distribution than expected.

Calculations were made according to the mixed effects model and the p value was checked according to the between-group heterogeneity test. In addition, the heterogeneity test Q statistical value of the study was determined as 1.170 and the degree of freedom was 1. The critical value of the χ^2 table at the 95% significance level is 0.445. It was observed that the calculated statistical value of Q was below the critical value determined in the 1 degree of freedom chi-square distribution. With this result, it was concluded that the effect sizes of CBL did not show a significant difference according to the education level categories of the students' science academic achievement.

Discussion and Conclusion

In the research, a Meta-Analysis of 23 researches was conducted to answer the question "What impact does CBL have on students' science achievement?" and the effect size was calculated. When the individual effect sizes of the researches were analyzed, Karslı-Baydere and Akın-Yanmaz (2019) has the smallest negative effect size of "-0.474". Çelebi (2021) has also the largest positive effect size of "2.084". When the individual effect sizes of the all researches included in the research were examined, it was determined that 22 studies were positive. This result shows that 95.62% of the studies are positive and 4.3% are

negative. The fact that the majority of the studies are positive shows that CBL has a positive effect on the achievement according to the teaching method prescribed in the program. When the effect size of 23 researches is determined, it is seen that 69.56% of them have “large” effect size in the classification of Cohen (1988), and 50% of them have "large level" effect size in the classification of Thalheimer and Cook (2002).

The Q statistical value obtained as a result of the Heterogeneity test applied to examine the distribution of the meta-analyzed studies was 67.179 ($p<0.05$) and the degree of freedom was 22. When the chi-square distribution in the degree of freedom was examined, it was seen that it exceeded the critical value. According to these results, it was determined that the studies included in the study showed a heterogeneous distribution. The effect size of CBL in science education on academic achievement was found to be positive and 0.928. When we look at the equivalence of this value in the effect size classification, it is expressed as a large level.

As a result of all the calculations carried out, it was concluded that the effect of CBL on the achievement of students is higher than the effect of the teaching method prescribed by the Ministry of National Education for the Science course, and there is a significant difference between the two methods. As a result of the literature review, no meta-analysis study on CBL was found. In general, it was seen that there were individual studies on CBL in 2008 and later years.

The study also examined the effects of CBL on academic achievement compared to studies in science (physics, chemistry and biology) fields. It was calculated that the effect sizes of the researches participating in the research were positive. The research with the highest effect size (0.940) is in chemistry and the research with the lowest effect size (0.608) is in physics. When the overall effect sizes of the researches were determined, it was seen that there was no significant difference between the groups and accordingly, there was no difference in academic achievement in science fields.

When examining the effect of studies carried out according to the field of science on academic achievement, the results obtained according to the calculated effect sizes showed that the effect size of the studies was positive. The research with the largest effect size was in the field of chemistry with 0.940, and the least study was in the field of physics with 0.608. When the overall effect sizes of this researches were investigated, no significant difference

was observed between the both groups. The result shows that there is no difference in terms of achievement according to education level.

Recommendations

For meta-analysis, which is a method that forms the cornerstone of individual studies and aims to obtain stronger studies by bringing them together, it is necessary to access individual studies. The compilation of studies that meet the criteria determined in meta-analysis studies poses a difficulty. In order to overcome this difficulty, it would be useful for such studies to create a larger database where studies conducted both in Turkey and abroad will be collected. It will facilitate the research process if the researchers proceed by coding at the beginning of the research.

In this study, it was concluded that the effect of CBL on science academic achievement was positive. Although the current system is student-centered, the teacher has an important position in understanding the subjects. For this reason, teachers can be given trainings on how the subjects are related to daily life and how to follow a way to transfer this to students. Comparisons can be made by looking at the education systems of other countries so that teachers can broaden their perspectives and improve themselves on this subject.

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Author Contribution Statement

Öznur KARASUBAŞI: *Literature review, determination of the problem situation, determining the method, selection of the studies for the research, collecting data, analyzing data, creating conclusion and discussion sections, reporting, writing, auditing and editing processes.*

Hatice GÜNGÖR SEYHAN: *Literature review, determination of the problem situation, determining the method, selection of the studies for the research, creating conclusion and discussion sections, auditing and editing processes.*

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