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Does Context-Based Learning Increase Academic Achievement and Learning Retention?: A Review based on Meta-Analysis

Özgür Tutal
Hakkari University, Faculty of Health Sciences, Hakkari, Turkey
Email: ozgurtutal@hakkari.edu.tr

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Abstract

The meta-analysis focuses on examining the effects of context-based learning on students' academic achievement and learning retention. A comprehensive search of the available research literature identified a total of 42 studies addressing academic achievement and 10 studies investigating learning retention. The findings of the analysis indicated that context-based learning had a statistically significant positive impact on both academic achievement (g=0.970) and learning retention (g=0.791) when compared to teacher-led instruction. These results were obtained using the random-effects model. To ensure the robustness of the findings, an assessment for publication bias was conducted. The analysis suggested that the observed effects were not influenced by publication bias. However, it is important to note that there was a notable variability in effect sizes across the included studies. To explore potential factors contributing to this heterogeneity, moderator analysis was performed on five possible moderator variables. The results of moderator analysis revealed that the impact of context-based learning on academic achievement was only moderated by group size. Specifically, studies with fewer than 50 participants demonstrated a strong effect (g=1.116), as did studies with 50-100 participants (g=1.096). On the other hand, studies with more than 100 participants exhibited a modest effect (g=0.498). These findings suggest that group size plays a role in moderating the effects of context-based learning on academic achievement. It implies that smaller groups may provide a more conducive environment for implementing context-based learning approaches, resulting in stronger effects compared to larger groups.

Keywords: Context-Based Learning, Academic Achievement, Learning Retention, Meta-Analysis

1. Introduction

In recent years, educational researchers and practitioners have shown a growing interest in exploring innovative approaches to enhance students' academic achievement and promote long-term learning retention. One such approach that has gained considerable attention is context-based learning (CBL). CBL is an instructional approach that recognizes the importance of both the social context within the learning environment and the practical, real-world context in the acquisition and comprehension of knowledge. This methodology is rooted in the strong belief that learning is inherently a social activity, and traditional classroom settings often fail to adequately support the natural processes of knowledge acquisition, processing, and production. Learning is a collaborative endeavor that thrives on meaningful interactions among individuals who share common interests, and conventional classroom structures that overlook this crucial aspect may hinder the effectiveness of the learning process (Rose, 2012).

Students often find themselves questioning the relevance and practicality of the subjects covered in their lessons, wondering why they should learn them and how they can apply the acquired knowledge in real-life situations. CBL addresses these concerns effectively by establishing a meaningful connection between everyday experiences and educational content, enabling students to discover the answers they seek. This approach leverages various real-life situations and challenges students encounter, allowing them to transfer course material in a practical context (Gilbert, 2006; Glynn & Winter, 2004; Tekbıyık, 2010).

CBL is an educational approach that promotes students' active engagement in their own learning process. It emphasizes the use of context as a powerful tool for constructing and understanding concepts (De Putter-Smits et al., 2016). The contexts that are the foundation for idea development should be relevant and relatable to students' lives, drawing from real-life experiences, social events, or scientifically valid situations (Bennett et al., 2007; Gilbert, 2006; Wieringa et al., 2011). By linking learning to everyday realities and issues in society or the economy, contexts bring coherence, connection, meaning, and relevance to the learning experience (Schwartz et al., 2004). They assume a central role in the learning process, acting as integrators that facilitate long-term comprehension and application of knowledge (Finkelstein, 2001). Contexts in CBL are closely connected to students' daily lives and address complex issues, fostering a deeper understanding of concepts (Di Fuccia & Ralle, 2016). Furthermore, learning occurs within the context and is derived from it, while transfer to other contexts is often facilitated in CBL environments through the use of examples and situations from diverse contexts (Taconis et al., 2016). This approach enables a "drip-feed" or "spiral curriculum" method, where ideas introduced in one context can be further developed and reinforced in other contexts, enhancing overall understanding (Bennett, 2016). By incorporating context throughout the learning process, CBL provides students with meaningful and interconnected learning experiences, allowing for deeper comprehension and application of concepts in various contexts.

Within the CBL approach, knowledge construction is stimulated through the recognition of the "need-to-know" within the given context and context-related tasks (Pilot & Bulte, 2006). CBL environments encourage students to ask questions and reward them for finding answers, drawing upon their existing knowledge (Bennett & Holman, 2003; Bennett et al., 2007). As such, CBL aligns with a constructivist view of learning, which emphasizes the active construction of knowledge (De Putter-Smits et al., 2016). From a constructivist perspective, Labudde (2008) identifies different dimensions. The first dimension pertains to individual learning, where knowledge is constructed by each learner. Consequently, what an individual learns is not a direct replica of reality or the content being taught but is influenced by the learner's pre-existing knowledge, beliefs, and interpretations. The second dimension highlights social interactions, emphasizing that knowledge construction occurs through exchanges with others. This process can be facilitated to foster the co-construction of knowledge, wherein students, either in interactions with peers or through discussions with their teachers, collaboratively build a knowledge base.

The third dimension focuses on the content itself. Labudde (2008, p. 141) states that "if learning is an active process of constructing new knowledge based on existing knowledge […], then the contents to be learned must be within the horizon of the learner." This perspective differs from traditional education, where concepts are typically presented first and then followed by applications. In contrast, CBL situates the content within the learner's horizon and allows for the exploration and application of concepts in relevant contexts from the outset. By embracing a constructivist view, CBL emphasizes the active role of the learner in constructing knowledge, the importance of social interactions, and the alignment of content with the learner's existing knowledge and experiences. This approach fosters a deeper understanding and meaningful engagement with the subject matter.

CBL has been found to have several benefits on learning outcomes. It facilitates the internalization of knowledge and facts by establishing connections to the learners' real-life experiences. By integrating learning with their lived realities, learners engage in a tyro researcher role where they actively participate in the production of knowledge. This hands-on experience transforms learning into a dynamic process of doing rather than a passive occurrence (Rose, 2012). Learning in context enhances students' ability to encode and retrieve information by creating meaningful associations. By placing knowledge within a relevant context, students can better comprehend complex ideas and retain them in long-term memory (Bransford et al., 2000). This approach also helps students transfer their knowledge to new situations, encouraging them to analyze problems, think critically, and apply their understanding in practical settings. By engaging in context-based problem-solving activities, students develop a deeper understanding of concepts and acquire essential problem-solving skills (Kolodner, 2002).

Moreover, learning within a meaningful context has been found to increase students' motivation and engagement in the learning process. When students see the relevance of what they are learning to their own lives, they become more interested and invested in their education. Learners are motivated to acquire knowledge as they perceive it to be valuable in solving specific problems or engaging with distinct realities. The learning process is driven by intrinsic motivation and genuine interest rather than external factors or punitive measures. (Rose, 2012). The work of Hidi and Renninger (2006) highlights the importance of situational interest, where students are motivated to learn because the context is personally meaningful to them. Besides, CBL facilitates the transfer of knowledge by explicitly linking theoretical concepts to practical contexts. It assists students in recognizing the connections between theoretical concepts and their everyday lives (Bennett, 2003). A study by Hattie (2009) showed that learning in context enhances students' ability to transfer their knowledge and skills beyond the classroom, enabling them to solve problems and make connections in various real-life scenarios.

Previous research has explored the impact of context-based learning on student outcomes, but there is a need for a meta-analysis to synthesize the existing evidence and provide a more comprehensive understanding of its effects. Meta-analytic studies are valuable as they enable researchers to examine the overall impact across multiple studies, thus enhancing the generalizability of the findings and providing a more robust assessment of the effectiveness of context-based learning. The present meta-analysis offers a comprehensive synthesis of the existing literature, allowing for a more reliable and robust estimation of the overall effect size (ES). By aggregating a large sample of studies, this meta-analysis can provide a more accurate assessment of the impact of CBL on students' academic achievement and learning retention. Furthermore, the meta-analysis enables the examination of potential sources of heterogeneity across studies. By identifying moderators, such as publication type, course type, educational level, experimental duration, and group size, this it can explore the conditions under which CBL is most effective. Also, this meta-analysis will contribute to the existing body of knowledge by synthesizing and analyzing the findings from previous studies on the effect of context-based learning on students' academic achievement and retention of learning. By examining a wide range of disciplines and educational settings, this research aims to provide educators and policymakers with valuable insights into the potential benefits and challenges associated with context-based learning. Ultimately, the findings from this meta-analysis will inform evidence-based instructional practices and guide future research in the field of education.

The primary objective of this meta-analysis is to assess the overall impact of CBL on students' academic achievement and retention of learning. By systematically reviewing and synthesizing the existing empirical evidence, this study seeks to provide a comprehensive understanding of the effectiveness of CBL across different publication types, course types, educational levels, experimental durations, and group sizes. Furthermore, this meta-analysis aims to identify potential moderators that may influence the relationship between CBL and student outcomes. To this end, the following questions were addressed in the present study:

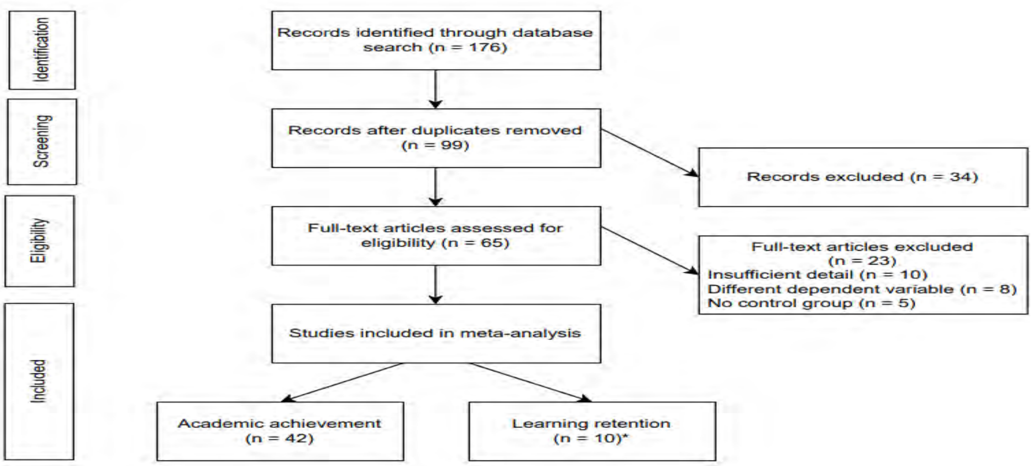
(1) What is the effect of CBL on students' academic achievement?
(2) What factors moderate the effect of CBL (if any) on students' academic achievement?
(3) What is the effect of CBL on learning retention?

2. Methods

In the review, meta-analysis was utilized to designate the overall effect of CBL on academic achievement and retention. Meta-analysis is a research methodology that combines the results of multiple studies by applying systematic and standardized methods of analysis. It allows for the exploration of patterns, trends, and differences across studies, enhancing the statistical power and generalizability of the findings (Cooper et al., 2019). The statistical analysis of a collection of analysis results from primary studies for the purpose of integrating the findings.

2.1. Literature Search

A search was carried out in September 2022 through the Turkish Council of Higher Education Thesis Centre, which is the largest academic database integrating masters' and doctoral theses in Turkey, to identify the primary studies. The keywords "context-based" and its equivalents in Turkish "bağlam temelli" and "yaşam temelli" were used for the literature search. In the initial search, 176 studies were found, and they were then reviewed by titles and abstracts by the author and a second researcher. After removing 77 duplicates and 34 irrelevant records, the remaining 65 studies were closely reviewed with inclusion criteria, and 42 studies (54 ESs) for academic achievement and 10 studies (12 ESs) for learning retention were finally identified as eligible for the meta-analysis. The identification, screening, eligibility, and inclusion stages of 176 studies listed as a result of the literature search and the number of studies investigated at each stage are presented in Figure 1.



* Ten studies reported both academic achievement and learning retention.

Figure 1. Flow Diagram for the Literature Search Process

2.2. Inclusion Criteria

The studies obtained through the database search were subjected to specific inclusion criteria, which encompassed the following parameters:

- The study should investigate the impact of CBL on academic achievement or retention.
- The study should have an experimental or quasi-experimental design with a pretest-posttest control group model.
- The study should be a thesis or dissertation.
- The study should be written in either English or Turkish.
- The study should have been published before September 2022.
- The study should have been conducted in Turkey.
- The study should include the necessary statistical information for calculating ESs.
- The study should be available in full text.

2.3. Coding Process

Primary studies were coded according to (a) author information, (b) publication type, (c) publication year, (d) course type, (e) educational level, (f) group size, (g) duration of experiment, (h) sample size, mean and standard deviation values of the groups. The author, together with another researcher, double-reviewed and independently coded all the required information. The interrater agreement rate (Miles & Huberman, 1994) was estimated as 99.6%, and disagreements were resolved until a consensus was reached after the double examination of the primary studies.

2.4. Model Choice and Heterogeneity Analysis

The selection of an appropriate model during the execution of a meta-analysis is a pivotal and consequential decision (Srinivasjois, 2021). Researchers must make a careful decision regarding the most appropriate statistical model to employ for their meta-analysis, considering the specific context and objectives (Slaney et al., 2018). When there is a lack of heterogeneity among primary studies within the meta-analysis and a valid assumption of a constant true effect, the fixed effects model is favored (Harrer et al., 2022). Conversely, if the goal is to generalize to a population with varying effects and characteristics across studies, the random effects model is utilized, acknowledging the potential variability of the actual effect (Hanji, 2017). The selection of an appropriate model holds significant importance in a meta-analysis, as it should align with the researcher's beliefs concerning the data's nature and the desired inferences (Konstantopoulos & Hedges, 2019; Rothstein et al., 2013). To ensure a well-informed decision, researchers are advised to consider the study scope, variables, and design prior to the analysis (Başol, 2016). Given the heterogeneous structure of the primary studies included in this meta-analysis, characterized by variations in course content, measurement tools, participant education levels, and age groups, it was determined that they did not share the same population parameters. Consequently, the random effects model was selected to estimate the overall ES before conducting the analysis.

To ensure accurate findings, it is advisable to account for data heterogeneity and inter-study variability when conducting meta-analyses (Khan, 2020). Assessing heterogeneity is a fundamental objective of meta-analysis, as it is an underlying assumption of the random-effects model (Huedo-Medina et al., 2006). The identification and evaluation of heterogeneity play a crucial role in understanding the variability observed among the included studies. In this particular meta-analysis, a thorough examination of heterogeneity was carried out to assess the variation among ESs from the primary studies included (Table 1). The analysis revealed that the Q values surpassed the critical values of the chi-square distribution (X^2), indicating significant heterogeneity among the ESs of the studies (Dinçer, 2014). Furthermore, high I^2 values of 85% and 61% indicated substantial levels of heterogeneity (Deeks et al., 2008).

Table 1. Results of Heterogeneity Analyses, by the Outcome

	df	*Q*	X^2	*p*	I^2
Academic achievement	53	362.626	73.311	0.000	85.384
Learning retention	11	28.632	19.675	0.003	61.581

2.5. Publication Bias Analyses

The current review employed various techniques to identify the existence of publication bias. Initially, a thorough visual examination was conducted by employing the funnel plot. Subsequently, multiple methodologies were employed, including the classical fail-safe N number (Rosenthal, 1979), Orwin's fail-safe N number (Orwin, 1983), and the trim and fill methods (Duval & Tweedie, 2000a, 2000b). These diverse approaches allowed for a comprehensive analysis of potential bias in the published literature.

2.6. Estimation of Effect Sizes

Given that the primary studies incorporated in the scope of this meta-analysis involved the average scores of both experimental and control groups, the review employed the "process effectiveness" method, as proposed by Durlak and Lipsey (1991). This particular method falls under the category of group comparison meta-analysis, enabling a comprehensive assessment of the data. Furthermore, due to the utilization of diverse scales to measure the academic achievement and retention levels across the primary studies, standardization of ESs was imperative. To achieve this, the coefficient developed by Hedges (1982) was employed, which estimates individual ESs using the formula:

"Hedges' g = (M1 - M2) / SDpooled" (1)

To interpret the ESs accurately, the classification suggested by Cohen et al. (2018) was adopted. According to this classification, ESs are considered weak if they fall within the range of 0-0.20, modest if they range from 0.21 to 0.50, moderate if they fall between 0.51 and 1, and strong if they surpass 1, indicating a substantial impact.

3. Results

3.1. Results for Academic Achievement

Within the scope of this meta-analysis, a total of 42 primary studies (encompassing 3938 students) successfully met the established inclusion criteria for the academic achievement variable. These studies, published between 2008 and 2022, yielded a total of 54 ESs. Table 2 provides an overview of the characteristics of the reviewed studies. It reveals that a majority of the included studies were published as master's theses (57.4%), conducted within the field of science courses (90.7%), focused on middle school students (44.4%), had an experimental duration ranging from 5 to 8 weeks (62.9%), and involved participant counts between 50 and 100 (51.8%).

Table 2. Categories and Results of the Moderator Analyses of Academic Achievement

Moderator	***k***	***ES (g)***	**95% CI**		***Q*$_b$**	***p***
			Lower L.	**Upper L.**		
Publication type	**54**				3.510	0.061
Master's thesis	31	1.120	0.844	1.396		
Doctoral dissertation	23	0.788	0.578	0.998		
Course type	**54**				2.313	0.128
Science	49	0.914	0.738	1.090		
Other courses	5	1.633	0.724	2.542		
Educational level	**54**				4.383	0.223
Elementary school	5	1.592	0.544	2.640		
Middle school	24	0.939	0.651	1.227		
High school	18	0.807	0.545	1.069		
Tertiary	7	1.166	0.852	1.480		
Experimental duration	**51[a]**				2.123	0.145
1-4 weeks	17	1.255	0.780	1.729		
5-8 weeks	34	0.875	0.684	1.065		
Group size	**54**				15.421	0.000*
≤ 50	16	1.116	0.705	1.528		
> 50. < 100	28	1.096	0.840	1.352		
≥ 100	10	0.498	0.290	0.707		

Note. Random effects model, *$p < .05$.

[a] The 9-12 weeks experimental duration had one study and two studies were not specified thus they were extracted from the analysis.

3.1.1. Overall Effect Size

The ESs derived from the primary studies investigating the impact of CBL on academic achievement exhibited a range from -0.474 to 4.798, as depicted in Figure 2. Among the 54 ESs analyzed, two displayed negative effects, while the remaining 52 demonstrated positive effects. Using the classification framework established by Cohen et al. (2018), it was observed that three of the positive studies yielded weak effects, seven exhibited modest effects, 23 displayed moderate effects, and 19 showed strong effects.

Meta Analysis

Study name	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Akdas	0,650	0,308	0,095	0,047	1,252	2,112	0,035
Akin-Yanmaz	0,801	0,335	0,112	0,144	1,457	2,390	0,017
Akpinar1	0,314	0,190	0,036	-0,058	0,687	1,654	0,098
Akpinar2	0,309	0,198	0,039	-0,079	0,697	1,561	0,119
Akpinar3	0,174	0,194	0,038	-0,206	0,555	0,898	0,369
Altay	0,855	0,278	0,078	0,309	1,400	3,069	0,002
Arikan	0,608	0,277	0,077	0,064	1,151	2,190	0,029
Aydin-Ceran1	2,360	0,307	0,094	1,758	2,962	7,683	0,000
Aydin-Ceran2	1,944	0,286	0,082	1,384	2,504	6,800	0,000
Badeli1	0,646	0,307	0,095	0,043	1,249	2,101	0,036
Badeli2	0,753	0,310	0,096	0,145	1,361	2,427	0,015
Badeli3	0,791	0,311	0,097	0,181	1,402	2,542	0,011
Bitir	4,798	0,555	0,308	3,711	5,886	8,650	0,000
Büyük-Kuloglu	0,425	0,251	0,063	-0,067	0,916	1,694	0,090
Can	0,993	0,280	0,078	0,445	1,541	3,550	0,000
Ceylan	0,907	0,256	0,065	0,405	1,408	3,543	0,000
Cam1	1,332	0,228	0,052	0,885	1,779	5,842	0,000
Cam2	1,029	0,220	0,048	0,598	1,459	4,686	0,000
Cam3	0,842	0,215	0,046	0,420	1,264	3,913	0,000
Cam4	1,305	0,227	0,052	0,860	1,750	5,745	0,000
Cam5	2,001	0,253	0,064	1,506	2,497	7,920	0,000
Celebi	2,084	0,461	0,212	1,181	2,987	4,524	0,000
Cigdemoglu	0,547	0,153	0,024	0,246	0,848	3,565	0,000
Demir	2,017	0,345	0,119	1,340	2,694	5,839	0,000
Elmas	0,951	0,142	0,020	0,673	1,228	6,718	0,000
Eren	1,178	0,302	0,091	0,586	1,771	3,898	0,000
Ergün	1,394	0,309	0,095	0,789	1,999	4,514	0,000
Gökce	1,202	0,303	0,092	0,607	1,797	3,961	0,000
Görmüs	0,831	0,266	0,071	0,310	1,352	3,125	0,002
Günes-Koc	0,883	0,302	0,091	0,292	1,474	2,929	0,003
Güney	0,803	0,272	0,074	0,270	1,336	2,953	0,003
Hosbas	-0,452	0,282	0,080	-1,006	0,101	-1,603	0,109
Ÿcöz	0,991	0,198	0,039	0,603	1,380	5,002	0,000
Kara	1,571	0,340	0,116	0,904	2,237	4,618	0,000
Karsli	-0,474	0,258	0,067	-0,980	0,033	-1,832	0,067
Kocayusuf	1,442	0,243	0,059	0,966	1,919	5,932	0,000
Konu1	0,133	0,194	0,038	-0,248	0,514	0,683	0,495
Konu2	0,398	0,196	0,038	0,014	0,782	2,030	0,042
Korsacÿlar	0,221	0,264	0,070	-0,298	0,739	0,835	0,404
Özkan	3,620	0,417	0,174	2,802	4,438	8,675	0,000
Özkan.	0,840	0,307	0,094	0,239	1,442	2,741	0,006
Ruscuklu	1,409	0,307	0,094	0,808	2,011	4,592	0,000
Sadi-Yilmaz	0,223	0,154	0,024	-0,079	0,524	1,449	0,147
Sari-Ay1	0,876	0,267	0,071	0,352	1,399	3,279	0,001
Sari-Ay2	0,332	0,257	0,066	-0,171	0,835	1,292	0,196
Sari-Ay3	0,149	0,255	0,065	-0,351	0,650	0,585	0,559
Siddik-Tag	1,165	0,256	0,066	0,663	1,667	4,546	0,000
Sunar	0,871	0,170	0,029	0,537	1,205	5,114	0,000
Tulum	0,619	0,339	0,115	-0,045	1,282	1,827	0,068
Tütüncü	0,749	0,278	0,077	0,205	1,294	2,697	0,007
Ulusoy	1,997	0,313	0,098	1,383	2,611	6,373	0,000
Uzun	0,629	0,283	0,080	0,075	1,183	2,224	0,026
Ünal	0,555	0,296	0,088	-0,025	1,135	1,876	0,061
Ünal.	1,566	0,277	0,077	1,023	2,108	5,656	0,000
	0,970	0,090	0,008	0,793	1,146	10,767	0,000

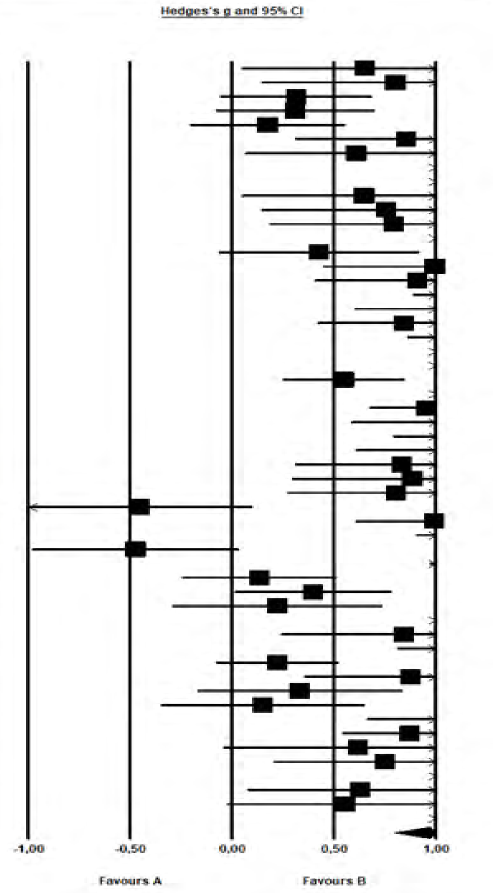


Figure 2. Forest Plot of Academic Achievement

Incorporating all the studies included in the analysis, the overall ES was estimated to be 0.970, with a standard error of 0.090, employing the random-effects model (p=0.000). The 95% confidence interval for the overall effect ranged from 0.793 (lower limit) to 1.146 (upper limit). According to the classification system suggested by Cohen et al. (2018), the overall ES fell within the moderate range. This indicates that CBL has a statistically significant and meaningful impact on student's academic achievement when compared to traditional lecture-based instruction. The positive overall ES of 0.970 underscores the effectiveness of CBL in enhancing academic achievement.

3.1.2. Publication Bias

As depicted in Figure 3, the ESs observed in the primary studies did not exhibit significant asymmetry. This finding suggests that the data displayed satisfactory symmetry and distribution. Consequently, in addition to the visual analysis, alternative methods were employed to identify the presence of publication bias within the meta-analysis.

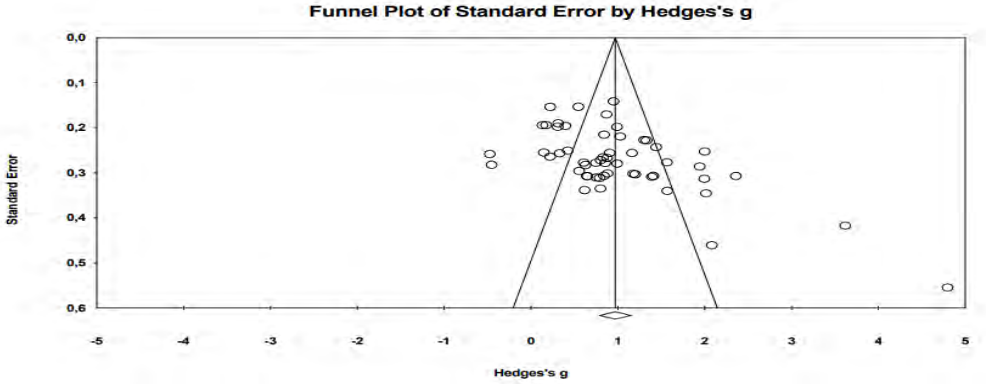


Figure 3. Funnel Plot of Academic Achievement

Based on the classic fail-safe N analysis (Rosenthal, 1979), a total of 9,501 missing studies with null effects would be required to overturn the observed findings. Similarly, Orwin's fail-safe N analysis (Orwin, 1983), suggested that a staggering 4,467,254 missing studies would be needed to reverse the results. The substantial number of missing studies indicated by both analyses exceeds the commonly applied '5k+10' threshold (Rosenthal, 1979). Furthermore, the trim-and-fill method (Duval & Tweedie, 2000a, 2000b) did not impute any additional ESs to the left or right of the funnel plot, suggesting that no studies needed to be trimmed or adjusted (Table 3). Taken together, the results of these statistical procedures collectively indicate that publication bias did not significantly influence the overall findings of the meta-analysis in a reliable manner.

Table 3. Findings of Publication Bias Tests

Test	Results	
Classic Fail-Safe N	Z value for observed studies	26.071
	p value for observed studies	0.000
	Alpha	0.05
	Tails	2
	Z for alpha	1.959
	Number of observed studies	54
	Number of missing studies that would bring the p-value to >alpha	9501
Orwin's Fail-Safe N	Hedges' g in observed studies (fixed effect)	0.827
	Criterion for a 'trivial' Hedges' g	0.00001
	Mean Hedges' g in missing studies	0.0000
	Number of missing studies needed to bring Hedge's g to under 0.001	4467254
Trim and Fill	Observed values	0.970
	Adjusted values	0.970
	Studies trimmed	0

3.1.3. Moderators

As presented in Table 1, the Q statistic value of 362.626 was found to be statistically significant ($p < 0.001$). With 53 degrees of freedom and a significance level of 95%, the X^2 value was determined to be 73.311. Given that the Q statistic surpassed the X^2 value, it indicated the presence of heterogeneity among the included studies. Furthermore, the I^2 value suggested that approximately 85% of the variance observed in the meta-analysis results could be attributed to between-study factors. In light of these findings, five moderator analyses were conducted to explore potential factors that could account for the observed heterogeneity. The objective was to provide plausible explanations for the variations found among the primary studies, as outlined in Table 2.

The results of the moderator analysis revealed that the summary ES of master's theses was associated with a strong effect (g=1.120). On the other hand, the summary ES of doctoral dissertations showed a moderate effect (g=0.788). Moreover, the between-group heterogeneity statistic for publication type was not found to be statistically significant (Q_b=3.510, p>0.05).

Upon comparing the ESs of the studies based on course types, it was found that science courses exhibited a moderate effect (g=0.914). Conversely, other courses showed a strong effect (g=1.633), suggesting a more pronounced positive impact on academic achievement. Additionally, the statistical analysis revealed that the difference between the ESs of the courses was not statistically significant (Q_b=2.313, p>0.05).

In the moderator analysis comparing educational levels, it was found that CBL had a moderate effect on academic achievement in both high school (g=0.807) and middle school (g=0.939) students. On the other hand, CBL had a strong effect on academic achievement in elementary school (g=1.592) and tertiary (g=1.166) students, indicating a significant positive impact in these groups. Furthermore, the between-group heterogeneity analysis results revealed that the difference between the ESs of the educational level groups was not statistically significant (Q_b=4.383, p>0.05).

In the moderator analysis examining the experimental duration of the studies, it was found that studies with an experimental duration of 1-4 weeks exhibited a strong effect (g=1.255) on academic achievement through CBL. Conversely, studies with an experimental duration of 5-8 weeks demonstrated a moderate effect (g=0.875). Furthermore, the Q_b statistics indicated that there was no statistically significant difference between the summary ESs of the groups formed based on the experimental duration (Q_b=2.123, p>0.05). These findings suggest that the publication type, course type, education level, and experimental duration did not significantly contribute to the observed heterogeneity in the meta-analysis results.

Within the moderator analysis, group size (total number of students in the experimental and control groups) emerged as another factor potentially contributing to heterogeneity. The findings revealed that studies with fewer than 50 participants exhibited a strong effect (g=1.116), as did studies with 50-100 participants (g=1.096). In contrast, studies with more than 100 participants showed a modest effect (g=0.498). Additionally, the heterogeneity analysis indicated that there was a statistically significant difference among the ESs of the groups based on group size (Q_b=15.421, p<0.05). This indicates that the variation in ESs observed across different group sizes significantly contributed to the overall heterogeneity observed in the meta-analysis results.

3.2. Results for Learning Retention

For the learning retention variable, a total of 10 primary studies (encompassing 662 students) met the inclusion criteria for this meta-analysis. These studies were published between 2013 and 2021 and yielded a total of 12 ESs. Detailed information on the characteristics of the included studies is presented in Table 4. Based on the data provided, it can be observed that the majority of the reviewed studies were published as master's theses (75%). Furthermore, the studies primarily focused on science courses (91.6%), middle school students (41.6%), and had an experimental duration of 1-4 weeks (50%). Additionally, a significant proportion of the studies involved fewer than 50 participants (58.3%).

Table 4. Characteristics of the Included Studies for Learning Retention

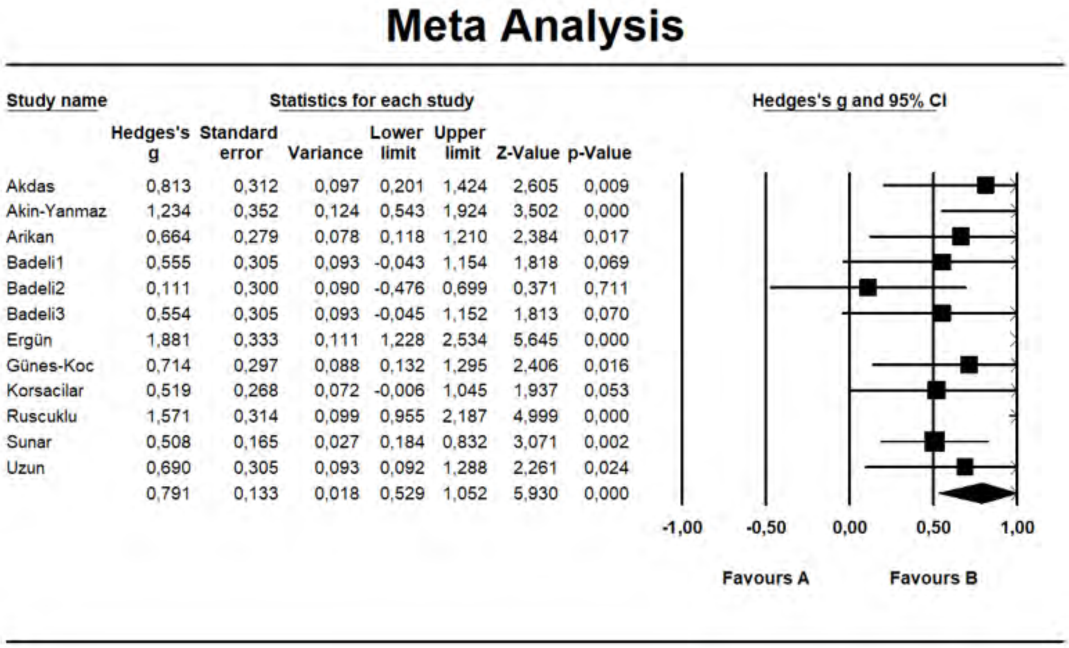
Moderator	***k***	***ES***	**95% CI**		***Qb***	***p***
		(g)	**Lower L.**	**Upper L.**		
Publication type	**12**				1.619	0.203
Master thesis	9	0.866	0.503	1.228		
Doctoral dissertation	3	0.579	0.328	0.831		
Course type	**12**				0.201	0.654
Social sciences	1	0.664	0.118	1.210		
Science	11	0.805	0.519	1.092		
Educational level	**12**				4.357	0.225
Elementary school	4	0.765	0.044	1.487		
Middle school	5	0.978	0.635	1.321		
High school	2	0.511	0.235	0.787		
Tertiary	1	0.690	0.092	1.288		
Experimental duration	**11**[a]				0.118	0.943
1-4 weeks	6	0.795	0.373	1.217		
5-8 weeks	5	0.816	0.384	1.247		
Group size	**12**				2.920	0.232
≤ 50	7	0.644	0.406	0.883		
> 50. < 100	4	1.138	0.491	1.785		
≥ 100	1	0.508	0.184	0.832		

Note. Random effects model

[a] A study was not specified and thus were extracted from the analysis.

3.2.1. Overall Effect Size

The ESs of the primary studies examining the effectiveness of CBL on learning retention varied between 0.111 and 1.881, as illustrated in Figure 4. It is worth noting that all 12 ESs were positive, indicating a positive impact of CBL on learning retention. According to the classification proposed by Cohen et al. (2018), one of the positive ESs was categorized as weak, eight were categorized as moderate, and three were categorized as strong. This classification system provides insights into the magnitude and interpretation of the ESs, suggesting that CBL has a notable and favorable influence on learning retention.



Study name	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Akdas	0,813	0,312	0,097	0,201	1,424	2,605	0,009
Akin-Yanmaz	1,234	0,352	0,124	0,543	1,924	3,502	0,000
Arikan	0,664	0,279	0,078	0,118	1,210	2,384	0,017
Badeli1	0,555	0,305	0,093	-0,043	1,154	1,818	0,069
Badeli2	0,111	0,300	0,090	-0,476	0,699	0,371	0,711
Badeli3	0,554	0,305	0,093	-0,045	1,152	1,813	0,070
Ergün	1,881	0,333	0,111	1,228	2,534	5,645	0,000
Günes-Koc	0,714	0,297	0,088	0,132	1,295	2,406	0,016
Korsacilar	0,519	0,268	0,072	-0,006	1,045	1,937	0,053
Ruscuklu	1,571	0,314	0,099	0,955	2,187	4,999	0,000
Sunar	0,508	0,165	0,027	0,184	0,832	3,071	0,002
Uzun	0,690	0,305	0,093	0,092	1,288	2,261	0,024
	0,791	0,133	0,018	0,529	1,052	5,930	0,000

Figure 4. Forest Plot of Learning Retention

The overall ES for the impact of CBL on learning retention was estimated to be 0.791, with a 95% confidence interval ranging from 0.529 to 1.052. The positive overall ES (g=0.791) indicates a statistically significant improvement in learning retention through the implementation of CBL, compared to traditional lecture-based instruction (p=0.000). In line with the classification proposed by Cohen et al. (2018), this ES falls into the moderate range.

3.2.2. Publication Bias

To assess the potential presence of publication bias, several procedures were implemented. Firstly, a visual examination of the distribution in the funnel plot revealed no substantial asymmetry, as depicted in Figure 5.

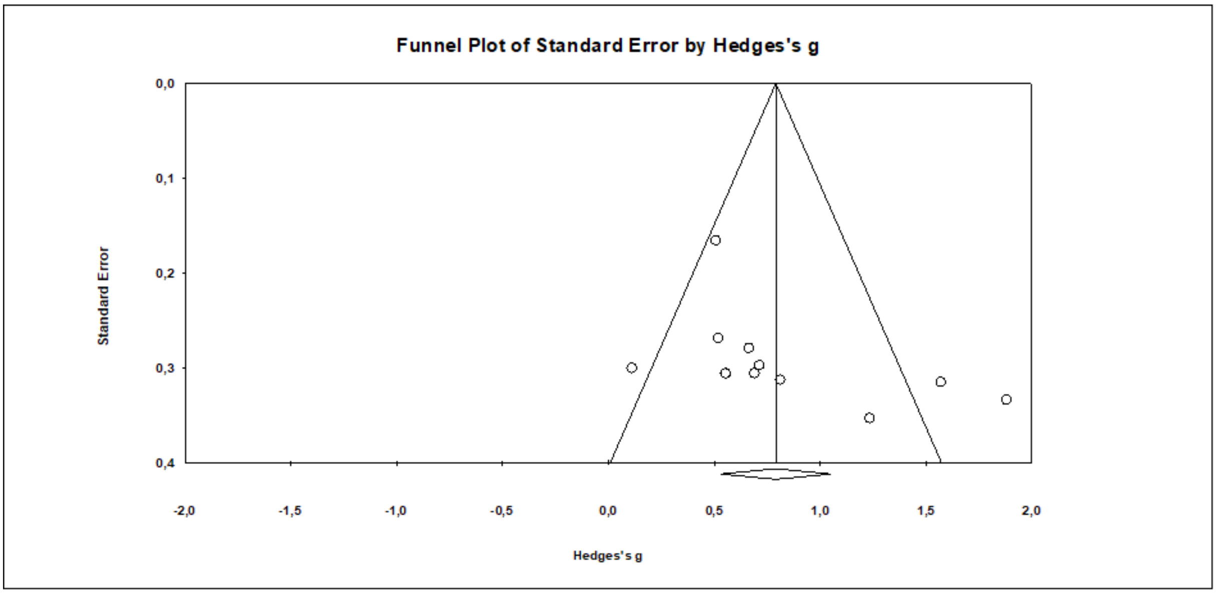


Figure 5. Funnel Plot of Learning Retention

Furthermore, the classic fail-safe N analysis (Rosenthal, 1979) indicated that a considerable number of 269 missing studies with null effects would be required to overturn the findings. Similarly, Orwin's fail-safe N analysis (Orwin, 1983) suggested that an enormous number of 880,684 missing studies would be needed to reverse the observed effect. These results surpass the established criterion of the '5k+10' limit (Rosenthal, 1979), indicating that the number of potentially missing studies is considerably larger than what could reasonably alter the conclusions. Additionally, the trim-and-fill method (Duval & Tweedie, 2000a, 2000b) did not impute any ESs to the left or right of the funnel plot, suggesting that no studies needed to be trimmed to achieve a more symmetrical distribution of results. This further supports the notion that publication bias is unlikely to have substantially impacted the findings. Taken together, considering the results obtained from the statistical procedures conducted, it can be concluded that publication bias did not appear to significantly affect the results of this meta-analysis.

Table 5. Findings of Publication Bias Tests

Test	Results	
Classic Fail-Safe N	Z value for observed studies	9.471
	p value for observed studies	0.000
	Alpha	0.05
	Tails	2
	Z for alpha	1.959
	Number of observed studies	12
	Number of missing studies that would bring the p-value to >alpha	269
Orwin's Fail-Safe N	Hedges' g in observed studies (fixed effect)	0.733
	Criterion for a 'trivial' Hedges' g	0.0001
	Mean Hedges' g in missing studies	0.0000
	Number of missing studies needed to bring Hedge's g to under 0.001	880684
Trim and Fill	Observed values	0.790
	Adjusted values	0.790
	Studies trimmed	0

4. Conclusion, Discussion and Recommendations

To investigate the impact of CBL on academic achievement, a comprehensive meta-analysis was conducted. The analysis incorporated data from 42 primary studies, encompassing a total of 3938 students. Within these studies, a total of 54 ESs were obtained, capturing a broad range of academic outcomes. Among the 54 ESs, only two studies reported negative effects, while the remaining studies demonstrated positive effects. The range of the ESs varied from -0.474 to 4.798, indicating substantial heterogeneity in the observed outcomes across the primary studies. Based on the classification proposed by Cohen et al. (2018), the ESs were further categorized. Three studies exhibited a weak effect, seven studies had a modest effect, 23 studies demonstrated a moderate effect, and 19 studies showed a strong effect of CBL on academic achievement. Considering the heterogeneity and variations across the primary studies in terms of course types, participants' education levels, age groups, and measurement tools employed, a random effects model was employed to estimate the overall ES. The random effects model takes into account the diversity among studies and provides a more conservative estimate. The results of the meta-analysis revealed an overall ES of 0.970 under the random effects model, indicating a significant positive impact of CBL on academic achievement. This finding suggests that CBL is associated with improved academic outcomes across a diverse range of study contexts.

The results of the moderator analysis indicated that the impact of CBL on academic achievement was influenced by group size. Specifically, the summary ESs of studies with smaller group sizes (fewer than 50 students and 50 to 100 students) were larger compared to studies with larger group sizes (more than 100 students). The observed differences in ESs based on group size suggest that smaller groups may provide certain advantages in implementing CBL approaches, leading to stronger effects on academic achievement. However, it is important to note that this finding should not be interpreted as CBL being ineffective for academic achievement in larger groups.

As part of the meta-analysis, an investigation was conducted on the effect of CBL specifically on learning retention. A total of 10 studies, comprising 12 ESs, were included in this analysis. The data used in these studies encompassed 662 students, with 330 students in the experimental group and 332 students in the control group. The ESs obtained from the primary studies exhibited a wide range, spanning from 0.111 to 1.881. Notably, all 12 ESs demonstrated positive effects, indicating the favorable impact of CBL on learning retention. Based on the classification proposed by Cohen et al. (2018), one of the studies displayed a weak effect, eight studies exhibited a moderate effect, and three studies revealed a strong effect in terms of learning retention resulting from CBL interventions. The overall ES, calculated as 0.791, was determined to assess the collective impact of CBL on learning retention. This finding suggests that CBL is more effective than traditional lecture-based instruction in enhancing students' ability to retain learned information over time. The results indicate a statistically significant advantage of CBL in promoting long-term retention of knowledge.

The overall ESs obtained for both academic achievement and retention variables in this review were categorized as moderate according to the classification proposed by Cohen et al. (2018). It is important to note that these categories are not universally applicable across all research fields and should be interpreted within the context of the specific research area (Grissom & Kim, 2011). In educational research, alternative benchmarks and criteria may be considered to assess the practical and pedagogical significance of ESs. For instance, Hattie (2009) suggests that an ES of 0.40 can serve as a benchmark for evaluating effects in the field of education, representing the typical ES encompassing various educational interventions. Additionally, Gall et al. (2003) propose that an ES of at least 0.33 is considered sufficient for practical significance in educational studies, while Slavin (1996) suggests that ESs of 0.20 or 0.25 are pedagogically important. Given these perspectives, the moderate ESs obtained in this meta-analysis can be considered quite remarkable for educational research. They indicate that CBL has a meaningful and significant impact on increasing academic achievement and learning retention compared to traditional educational approaches. However, it is essential to consider the specific context and characteristics of the studies included in the meta-analysis, as well as the factors influencing ESs in the field of education. These findings provide valuable insights into the effectiveness of CBL in educational settings and highlight its potential to enhance student outcomes.

Academic achievement is a fundamental goal of education systems worldwide. In recent years, there has been growing recognition of the significance of CBL as a pedagogical approach that can positively impact students' academic performance. CBL engages students by connecting abstract concepts to real-life scenarios, making learning more meaningful and relevant. Research has shown that when students perceive the content as personally relevant and applicable, their motivation and engagement increase (Pintrich & De Groot, 1990). This heightened motivation leads to sustained effort and improved academic achievement. By presenting knowledge in authentic contexts, CBL promotes deep learning and conceptual understanding. When students can see the connections between what they learn and real-world applications, they are more likely to engage in critical thinking, problem-solving, and higher-order cognitive processes (Hmelo-Silver, 2004). These processes enhance comprehension, retention, and transfer of knowledge, ultimately leading to improved academic achievement.

Another reason why CBL can increase academic achievement is that it fosters the development of transferable skills. These transferable skills are essential for academic success and future career readiness, enabling students to apply their knowledge across disciplines and solve complex problems. Also, CBL often involves active and experiential learning approaches, such as hands-on experiments, field trips, and simulations. These methods provide students with opportunities to explore and interact with the subject matter directly, fostering deeper understanding and long-term retention (Furtak et al., 2012). Active learning promotes student engagement, enhances critical thinking skills, and improves academic achievement.

Moreover, CBL often incorporates collaborative learning and social interaction, encouraging students to work together to solve problems or complete projects. Collaborative learning enhances academic achievement through peer support, collective knowledge construction, and the development of interpersonal skills (Johnson & Johnson, 1989). Engaging in meaningful interactions with peers fosters deeper understanding and promotes higher levels of achievement.

Learning retention, on the other hand, the ability to recall and apply learned information over time is a critical aspect of education. CBL provides students with meaningful and relatable learning experiences, linking abstract concepts to real-world contexts. Research has shown that when students can relate new information to their existing knowledge and experiences, they are more likely to retain and recall that information over time (Bruner, 1996). By connecting learning to practical applications, CBL enhances the relevance and personal significance of the content, leading to improved retention.

Besides, CBL supports the development of schemas, mental frameworks that help organize and store knowledge. When students encounter information in authentic contexts, they are more likely to form rich, interconnected networks of knowledge (Bransford et al., 2000). These schemas enable students to encode information more effectively, enhancing retention and facilitating retrieval when needed. One key aspect of CBL is the application of knowledge and skills to real-world situations. Research suggests that when learners can transfer their learning to different contexts, it enhances retention (Detterman, 1993). By engaging in CBL, students acquire a deeper understanding of concepts, allowing them to apply their knowledge flexibly and retain it in a more robust manner.

Another reason why CBL increases learning retention is that it often involves multiple modalities and sensory engagement, such as hands-on experiments, simulations, and multimedia resources. Research has shown that engaging multiple senses during learning enhances memory and retention (Mayer, 2009). By incorporating various modalities, CBL optimizes sensory experiences, increasing the likelihood of long-term retention. Also, it encourages spaced practice and retrieval practice, both of which have been found to improve retention. Spaced practice involves distributing learning sessions over time, allowing for better consolidation and retention of information (Cepeda et al., 2006). Retrieval practice involves actively recalling information from memory, strengthening memory traces, and promoting long-term retention (Roediger & Karpicke, 2006). CBL often provides opportunities for repeated retrieval practice in realistic settings, enhancing learning retention.

The present review acknowledges several limitations that should be considered when interpreting the findings. One limitation is the presence of heterogeneity among the ESs of the primary studies, as indicated by the results of the heterogeneity analysis. To explore the potential sources of heterogeneity, moderator analyses based on subgroup comparisons are recommended (Song et al., 2001). However, it is important to note that for moderator analyses to yield robust results, each subgroup should ideally contain at least 10 studies, as suggested by Borenstein et al. (2009) and Hedges and Olkin (1985). In this review, moderator analyses were conducted for the academic achievement variable, allowing for a better understanding of the factors contributing to the observed heterogeneity. However, due to the limited number of studies available for the learning retention variable, it was not possible to perform moderator analyses for this variable. This limitation highlights the need for more primary studies examining the effect of CBL on learning retention in order to conduct more comprehensive meta-analyses in the future.

Indeed, the limited scope of the meta-analysis focusing solely on the impact of CBL on academic achievement and learning retention is a notable limitation. It is important to recognize that CBL can potentially influence various other variables that are relevant to educational outcomes. Therefore, future meta-analyses should aim to include a broader range of variables, such as attitudes toward the course, problem-solving skills, scientific reasoning abilities, creativity, critical thinking skills, motivation, and self-efficacy. By considering a wider array of outcomes, a more comprehensive understanding of the effects of CBL can be obtained. Another limitation of the present review is the inclusion of studies conducted exclusively in Turkey. This geographic restriction may limit the generalizability of the findings to other cultural and educational contexts. It is advisable for future meta-analyses to include studies conducted in different countries to enhance the external validity of the results and provide a more diverse perspective on the effects of CBL.

Additionally, the meta-analysis focused solely on master's theses and doctoral dissertations, omitting relevant studies published as articles or conference proceedings. By incorporating a wider range of sources, including peer-reviewed articles and conference presentations, future meta-analyses can capture a more comprehensive pool of research findings and increase the robustness of the synthesized evidence. Finally, based on the findings of the meta-analysis, educators are advised to consider incorporating CBL strategies into their instructional practices to support student’s academic achievement, optimize learning outcomes, and promote sustained retention.

References

References marked with an asterisk indicate studies included in the meta-analysis.

*Akdaş, E. (2014). *İlköğretim yedinci sınıf fen ve teknoloji dersi insan ve çevre ünitesinde yaşam temelli öğrenme modelini kullanmanın akademik başarı, tutum ve kalıcılık üzerine etkisi [The effect of using context-based learning model in seventh grade science and technology course, environment and human unit, on students' academic achievements, attitudes towards environment and knowledge retention]* [Unpublished master’s thesis]. Gazi University, Ankara.

*Akın-Yanmaz, E. (2021). *Bağlam temelli öğrenme yaklaşımına göre geliştirilen rehber materyallerin ortaokul 7. sınıf öğrencilerinin kavramsal anlamaları üzerine etkisi: “Aynalar ve ışığın soğurulması” örneği [The effect of guide materials developed according to context-based learning approach on the conceptual understanding of 7th grade students: "Mirrors and absorption of light"]* [Unpublished master’s thesis]. Giresun University, Giresun.

*Akpınar, M. (2012). *Bağlam temelli yaklaşımla yapılan fizik eğitiminde kavramsal değişim metinlerinin öğrenci erişisine etkisi [The effect of the conceptual change texts on student achievement gain at physics education carried out with context based approach]* [Unpublished doctoral dissertation]. Gazi University, Ankara.

*Altay, C. A. (2018). *Bağlam temelli öğretim yaklaşımının 9. sınıf öğrencilerinin kimya bilimi ünitesine ilişkin başarılarına tutumlarına ve bilimin doğası anlayışlarına etkisi [The effect of context based learning on the 9th grade students' success in chemical sciences unit attitudes towards chemistry lesson and perception of the nature of science]* [Unpublished doctoral dissertation]. Gazi University, Ankara.

*Arıkan, İ. (2021). *Sosyal bilgiler dersinde bağlam temelli öğrenme yaklaşımının öğrencilerin akademik başarısına, finansal okuryazarlık becerilerine ve öğrenmenin kalıcılığına etkisi [The effect of context based learning approach on students' academic achievement, financial literacy skills and retention of learning in social studies]* [Unpublished doctoral dissertation]. Fırat University, Elazığ.

*Aydın-Ceran, S. (2018). *Yaşam temelli bağlamlarla desteklenmiş 5e modelinin farklı bilişsel stillerdeki öğrencilerin kavramsal anlama düzeyleri ve bilimsel süreç becerilerine etkisi [The effects of 5e models supported life-based contexts on the conceptual understanding levels and scientific process skills of the students with different cognitive styles]* [Unpublished doctoral dissertation]. Gazi University, Ankara.

*Badeli, Ö. (2017). *İlkokul 4. sınıf “saf madde ve karışım” konusunun öğretiminde 5e modeli ile desteklenen bağlam temelli öğretim yönteminin öğrencilerin kavramsal anlamalarına, fene yönelik tutumlarına ve bilgilerinin kalıcılığına etkisinin incelenmesi [Investigation of the impact of the context based teaching method supported by the 5e model in teaching primary school 4th grade students the "pure material and mixture" topic on the students' conceptual perceptions, their attitude towards science and the memorability of their knowledge]* [Unpublished master’s thesis]. Gaziantep University, Gaziantep.

Başol, G. (2016). "Türkiye örnekleminde meta analiz çalışmalarının içerik analizi ve metodolojik değerlendirilmesi" konusunda Dinçer (2016) "Editöre Mektup"a cevaben [Response Letter to Editor: In response to The Letter to Editor by Dinçer (2016): Concerning “A content analysis and methodological evaluation of meta-analyses on Turkish samples”]. *International Journal of Human Sciences*, *13*(1), 1395–1401. https://doi.org/10.14687/ijhs.v13i1.3694

Bennett, J. (2003). *Teaching and learning science: A guide to recent research and its applications.* Continuum.

Bennett, J. (2016). Bringing science to life: Research evidence. In R. Taconis, P. den Brok, & A. Pilot (Eds.), *Teachers creating context-based learning environments in science* (pp. 21-40). Sense Publishers.

Bennett, J., & Holman, J. (2003). Context-based approaches to the teaching of chemistry: What are they and what are their effects? In J. K. Gilbert, O. De Jong, R. Justi, D. F. Treagust, & J. H. Van Driel (Eds.), *Chemical education: Towards research-based practice* (pp. 165–184). Springer.

Bennett, J., Lubben, F., & Hogarth, S. (2007). Bringing science to life: A synthesis of the research evidence on the effects of context-based and STS approaches to science teaching science education. *Science Education*, *91*(3), 347–370. https://doi.org/10.1002/sce.20186

*Bitir, T. (2017). *Bağlam temelli kelime öğretimi yönteminin kelime kazanımına katkısı [Contribution of context based vocabulary teaching method to word acquisition]* [Unpublished master's thesis]. Uşak University, Uşak.

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2009). *Introduction to meta-analysis.* John Wiley & Sons.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school.* National Academies Press.

Bruner, J. S. (1996). *The culture of education*. Harvard University Press.

*Büyük-Kuloğlu, Z. (2019). *Yaşam temelli öğrenme yaklaşımının 6. Sınıf öğrencilerinin maddenin tanecikli yapısı konusundaki başarılarına ve motivasyonlarına etkisi [The effect of context based learning approach on the success and motivation of 6th grade students' about the particular structure of the matter]* [Unpublished master's thesis]. Düzce University, Düzce.

*Can, M. (2017). *Farklı kavramsal değişim stratejileriyle zenginleştirilmiş bağlam temelli yaklaşımın madde ve özellikleri konusunun anlaşılmasına etkisi [The effect of context-based approach enriched with different conceptual change strategies on matter end properties]* [Unpublished master's thesis]. Giresun University, Giresun.

Cepeda, N. J., Pashler, H., Vul, E., Wixted, J. T., & Rohrer, D. (2006). Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychological Bulletin, 132*(3), 354-380.

*Ceylan, D. (2017). *Coğrafya eğitiminde 5e modeliyle uygulanan bağlam temelli öğretim yaklaşımının akademik başarıya etkisi [The effect of context-based learning approach practiced in geography education in parallel with 5e model on academic success]* [Unpublished doctoral dissertation]. Gazi University, Ankara.

*Çam, F. (2008). *Biyoloji derslerinde yaşam temelli öğrenme yaklaşımının etkileri [The effects of context-based learnıng approach ın bıology lesson]* [Unpublished master's thesis]. Atatürk University, Erzurum.

*Çelebi, E. (2021). *8.sınıf basınç ünitesi öğretiminde uygulanan bağlam temelli öğrenme yaklaşımının öğrencilerin bilgilerini günlük yaşamla ilişkilendirebilme düzeylerine ve akademik başarılarına etkisi [The effect of the concept based learning approach that is carried out in teaching the unit named ''pressure'' at 8th grade on students' level of associating knowledge to daily life and their academic achievements]* [Unpublished master's thesis]. Dicle University, Diyarbakır.

*Çiğdemoğlu, C. (2012). *Effectiveness of context-based approach through 5e learning cycle model on students' understanding of chemical reactions and energy concepts, and their motivation to learn chemistry* [Unpublished doctoral dissertation]. Middle East Technical University, Ankara.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education*. Routledge.

Cooper, H., Hedges, L. V., & Valentine, J. C. (Eds.). (2019). *The handbook of research synthesis and meta-analysis.* Russell Sage Foundation.

De Putter-Smits, L. G. A., Taconis, R., & Jochems, W. M. G. (2016). Measuring context-based learning environments in Dutch science classrooms. In R. Taconis, P. den Brok, & A. Pilot (Eds.), *Teachers creating context-based learning environments in science* (pp. 103-124). Sense Publishers.

Deeks, J. J., Higgins, J. P. T., & Altman, D. G. (2008). Analysing data and undertaking meta-analyses. In J. P. T. Higgins & S. Green (Eds.), *Cochrane handbook for systematic reviews of interventions* (pp. 243-296). John Wiley & Sons.

*Demir, İ. (2019). *Yaşam temelli öğretimin ortaokul 7.sınıf öğrencilerinin ağız ve diş hijyeni konusunda kavram öğrenmelerine, fen bilimlerine karşı tutumlarına ve motivasyonlarına etkisi [Context based teaching in secondary school 7 the effect of primary school students' on oral and dental hygiene, their attitudes towards science and their motivation]* [Unpublished master's thesis]. Marmara University, İstanbul.

Detterman, D. K. (1993). The case for the prosecution: Transfer as an epiphenomenon. In D. K. Detterman & R. J. Sternberg (Eds.), *Transfer on trial: Intelligence, cognition, and instruction* (pp. 1-24). Ablex Publishing.

Di Fuccia, D. S., & Ralle, B. (2016). Teachers in learning communities: an ınsight into the work of the project chemie im kontext. In R. Taconis, P. den Brok, & A. Pilot (Eds.), *Teachers creating context-based learning environments in science* (pp. 89-102). Sense Publishers.

Dinçer, S. (2014). *Eğitim bilimlerinde uygulamalı meta-analiz [Applied meta-analysis in educational sciences]*. Pegem Akademi.

Durlak, J. A., & Lipsey, M. W. (1991). A practitioner's guide to meta-analysis. *American Journal of Community Psychology*, *19*(3), 291-332.

Duval, S. & Tweedie, R. (2000a). A nonparametric "trim and fill" method of accounting for publication bias in meta-analysis. *Journal of the American Statistical Association*, 95 (449), 89-98. https://doi.org/10.1080/01621459.2000.10473905

Duval, S. & Tweedie, R. (2000b). Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics*, 56, 455-463. https://doi.org/10.1111/j.0006-341X.2000.00455.x

*Elmas, R. (2012). *The effect of context based ınstructıon on 9th grade students' understandıng of cleanıng materıals topıc and theır attıtude toward envıronment* [Unpublished doctoral dissertation]. Middle East Technical University, Ankara.

*Eren, A. (2022). *Popüler bilim dergileri destekli yaşam temelli öğretim uygulamalarının akademik başarıya etkisi: güneş sistemi ve tutulmalar ünitesi örneği [The effect of supported life-based teaching practices in popular science journals on academic achievement: the example of the solar system and eclipses unit]* [Unpublished master's thesis]. Bursa Uludağ University, Bursa.

*Ergün, E. C. (2018). *4. sınıf basit elektrik devreleri konusunun öğretiminde bağlam temelli öğretim yönteminin öğrencilerin fene yönelik tutumlarına, başarılarına ve bilgilerinin kalıcılığına etkisi [The effect of context- based learning method on students' science info for attitudes, success and impact retention of teaching simple electric circuits 4th grade]* [Unpublished master's thesis]. Gaziantep University, Gaziantep.

Finkelstein, N. (2001, July). Context in the context of physics and learning. In *Physics Education Research Conference Proceedings. Rochester,* NY: PERC Publishing.

Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and quasi-experimental studies of inquiry-based science teaching: A meta-analysis. *Review of Educational Research, 82*(3), 300-329.

Gall, M. D., Gall, J. P. & Borg, W. R. (2003). *Educational research: An introduction.* Allyn and Bacon.

Gilbert, J. K. (2006). On the nature of "context" in chemical education. *International Journal of Science Education, 28*(9), 957-976. https://doi.org/10.1080/09500690600702470

Glynn, S. M., & Winter, L. K. (2004). Contextual teaching and learning of science in elementary schools. *Journal of Elementary Science Education, 16*(2), 51-63.

*Gökçe, B. (2018). *Yaşam temelli öğrenme yaklaşımının 6. sınıf öğrencilerinin elektriğin iletimi ünitesine yönelik başarı, tutum ve motivasyonları üzerine etkisi [Effects of the life based learning approach applied at class 6 electricity transportation on success, attitude and motivation of students]* [Unpublished master's thesis]. Gazi University, Ankara.

*Görmüş, G. (2021). *Dolaşım sistemi konusunun öğretiminde bağlam temelli öğrenme yaklaşımındaki react stratejisine göre hazırlanan etkinliklerin öğrencilerin öğrenme ürünleri üzerine etkisi [The effect of the context-based learning approach based on the react strategy in teaching the subject of the circulatory system on the learning products of the students]* [Unpublished master's thesis]. Ondokuz Mayıs University, Samsun.

Grissom, R. J., & Kim, J. J. (2012). *Effect sizes for research: Univariate and multivariate applications*. Routledge.

*Güneş-Koç, R. S. (2013). *5e modeli ile desteklenen bağlam temelli yaklaşımın yedinci sınıf öğrencilerinin ışık ünitesindeki başarılarına, bilgilerinin kalıcılığına ve fen dersine karşı olan tutumlarına etkisi [The effect of context based approach supported by 5e learning model on 7th grade students' achievements, retention and attitude on the unit "Light"]* [Unpublished doctoral dissertation]. Gazi University, Ankara.

*Güney, F. (2019). *Yaşam temelli öğrenme yaklaşımı ile destekli çevre eğitiminin ortaokul 7. sınıf öğrencilerinin çevreye yönelik tutum, davranış ve başarılarına etkisi [The effect of environment education supported by context-based learning approach on environmental attitudes, behaviors and succes of 7th grade secondary school students]* [Unpublished master's thesis]. Gazi University, Ankara.

Hanji, M. B. (2017). *Meta-analysis in psychiatry research: Fundamental and advanced methods*. CRC Press.

Harrer, M., Cuijpers, P., Furukawa, T. A., & Ebert, D. D. (2022). *Doing meta-analysis with R: A hands-on guide.* CRC Press.

Hattie, J. A. C. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* Routledge.

Hedges, L. V. (1982). Estimation of effect size from a series of independent experiments. *Psychological Bulletin*, *92*(2), 490-499. https://doi.org/10.1037/0033-2909.92.2.490

Hedges, L. V., & Olkin, I. (1985). *Statistical methods for meta-analysis*. Academic Press.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, *41*(2), 111-127. https://doi.org/10.1207/s15326985ep4102_4

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 29*(3), 723-749.

*Hoşbaş, A. A. (2018). *Fen bilimleri öğretiminde yaşam temelli öğrenme yaklaşımının öğrenme ürünleri üzerine etkisi [Context-based learning approach on learning products in science teaching]* [Unpublished master's thesis]. Kırıkkale University, Kırıkkale.

Huedo-Medina, T. B., Sánchez-Meca, J., Marín-Martínez, F., & Botella, J. (2006). Assessing heterogeneity in meta-analysis: Q statistic or I^2 index? *Psychological Methods*, 11 (2), 193-206. https://doi.org/10.1037/1082-989X.11.2.193

*İçöz, Ö. F. (2016). *Effectiveness of context based instruction on 10th grade students' understanding of fossil fuels and clean energy resources topics and their attitudes toward environment [Unpublished doctoral dissertation].* Middle East Technical University, Ankara.

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research*. Interaction Book Company.

*Kara, F. (2016). *5. sınıf "maddenin değişimi" ünitesinde kullanılan bağlam temelli öğrenmenin öğrencilerin bilgilerini günlük yaşamla ilişkilendirme düzeyleri, akademik başarıları ve fene yönelik tutumlarına etkisi [The effect of context based learning used in 5th grade "change of substance" unit on the students' levels of association the knowledge with daily life, academic achievements and attitudes towards science lesson]* [Unpublished doctoral dissertation]. Ondokuz Mayıs University, Samsun.

*Karslı, G. (2019). *Yaşam temelli öğrenme yönteminin 8. Sınıf ses ünitesinde öğrencilerin akademik başarısına ve fen dersine karşı tutumuna etkisi [The effect of context based learning method on students' academic achievement and attitude towards science lesson in grade 8 'sound unit']* [Unpublished master's thesis]. Atatürk University, Erzurum.

Khan, S. (2020). *Meta-analysis: Methods for health and experimental studies.* Springer.

*Kocayusuf, A. G. (2013). *İlköğretim matematik eğitiminde yaşam temelli senaryolarla desteklenmiş tam öğrenme stratejisinin öğrencilerin öğrenme ürünleri üzerine etkisi [The effects of learning products of context based scenario accompanied mastery learning strategy]* [Unpublished master's thesis]. Akdeniz University, Antalya.

Kolodner, J. L. (2002). Facilitating the learning of design practices: Lessons learned from an inquiry into science education. *Journal of Industrial Teacher Education, 39*(3), 7-40.

Konstantopoulos, S., & Hedges, L. V. (2019). Statistically analyzing effect sizes: Fixed- and random-effects models. In H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.), *The handbook of research synthesis and meta-analysis* (pp. 245–280). Russell Sage Foundation.

*Konu, M. (2017). *Yaşam temelli probleme dayalı öğretim uygulamalarının öğrencilerin biyoloji dersindeki başarılarına, tutumlarına, motivasyonlarına ve problem çözme becerilerine etkisi [The effect of context- and problem-based instruction on the students' achievements, attitudes, motivations and problem-solving skills in biology course]* [Unpublished doctoral dissertation]. Atatürk University, Erzurum.

*Korsacılar, S. (2014). *9. sınıf fiziğin doğası ünitesindeki temel kavramların öğretiminde yaşam temelli öğretim ve öğrenme istasyonları yönteminin etkililiği [The effectiveness of real life context-based teaching and learning stations methods in teaching basic concepts in the 9th grade nature of physics unit]* [Unpublished master's thesis]. Dokuz Eylül University, İzmir.

Labudde, P. (2008). The role of constructivism in science education: Yesterday, today, and tomorrow. In S. Mikelskis-Seifert, U. Ringelband, & M. Bruckmann (Eds.), *Four decades in research of science education - From curriculum development to quality improvement* (pp. 139–156). Waxmann Verlag.

Mayer, R. E. (2009). *Multimedia learning*. Cambridge University Press.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.

Orwin, R. G. (1983). A fail-safe N for effect size in meta-analysis. *Journal of Educational Statistics*, *8*(2), 157-159. https://doi.org/10.3102%2F10769986008002157

*Özkan, G. (2013). *Kavramsal değişim metinleri ve yaşam temelli öğrenmenin öğrencilerin fizik öğrenme yaklaşımları ve kavramsal anlamaları üzerindeki etkileri [The effects of conceptual change texts and real life context- based learning on students approaches to learning physics and their conceptual understandings]* [Unpublished master's thesis]. Dokuz Eylül University, İzmir.

*Özkan, H. (2021). *Ortaokul öğrencilerine fen bilimleri dersinde girişimcilik becerilerinin gelişimine bağlam temelli öğrenmenin etkisinin incelenmesi [Investigation of the effect of context-based learning on the development of entrepreneurship skills in the science course of secondary students]* [Unpublished master's thesis]. Çukurova University, Adana.

Pilot, A., & Bulte, A. M. (2006). Why do you "need to know"? Context-based education. *International Journal of Science Education, 28*(9), 953-956. https://doi.org/10.1080/09500690600702462

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *82*(1), 33-40.

Roediger, H. L., & Karpicke, J. D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science, 17*(3), 249-255.

Rose, D. E. (2012). Context-based learning. In N. M. Seel (Ed.), *Encyclopedia of the sciences of learning*. Springer.

Rosenthal, R. (1979). The "file drawer problem" and tolerance for null results. *Psychological Bulletin*, 86 (3), 638-641. https://psycnet.apa.org/doi/10.1037/0033-2909.86.3.638

Rothstein, H. R., Lortie, C. J., Stewart, G. B., Koricheva, J., & Gurevitch, J. (2013). Quality standards for research syntheses. In J. Koricheva, J. Gurevitch, & K. Mengersen (Eds.), *Handbook of meta-analysis in ecology and evolution* (pp. 323–338). Princeton University Press.

*Rusçuklu, R. (2017). *Yaşam temelli öğrenme yaklaşımının 6.sınıf öğrencilerinin "maddenin tanecikli yapısı" ünitesindeki akademik başarı ve kalıcılıklarına etkisi [The effects of context-based learning approach to academic achievements and retention of knowledge in the 'particular structure of matter' unit of the sixth graders]* [Unpublished master's thesis]. Uludağ University, Bursa.

*Sadi-Yılmaz, S. (2013). *Kimyasal değişimler ünitesinin işlenmesinde yaşam temelli öğrenme yaklaşımının etkileri [The effects of the context- based learning approach on the training of chemical changes unit]* [Unpublished doctoral dissertation]. Atatürk University, Erzurum.

*Sarı-Ay, Ö. (2017). *Yaşam temelli fen eğitiminin öğrenci başarısına ve çevre bilinci üzerine etkisi [The effects of context based science education on student success and environmental consciousness]* [Unpublished doctoral dissertation]. Hacettepe University, Ankara.

Schwartz, R. S., Lederman, N. G., & Crawford, B. A. (2004). Developing views of nature of science in an authentic context: An explicit approach to bridging the gap between nature of science and scientific inquiry. *Science Teacher Education, 88*(4), 610–645. https://doi.org/10.1002/sce.10128

Slaney, K. L., Tafreshi, D., & Hohn, R. (2018). Random or fixed? An empirical examination of meta-analysis model choices. *Review of General Psychology*, *22*(3), 290-304. https://doi.org/10.1037/gpr0000140

Slavin, R. E. (1996). *Education for all.* Swets & Zeitlinger.

Song, F., Sheldon, T. A., Sutton, A. J., Abrams, K. R., & Jones, D. R. (2001). Methods for exploring heterogeneity in meta-analysis. *Evaluation & the Health Professions*, 24(2), 126–151. https://doi.org/10.1177/0163278701 02400203

Srinivasjois, R. (2021). Fixed and random-effects models for meta-analysis. In S. Patole (Ed.), *Principles and practice of systematic reviews and meta-analysis* (pp. 73–78). Springer.

*Sunar, S. (2013). *The effect of context-based instruction integrated with learning cycle model on students' achievement and retention related to states of matter subject* [Unpublished doctoral dissertation]. Middle East Technical University, Ankara.

Taconis, R., den Brok, P. & Pilot, A. (2016). Introduction: Context-based learning environments in science. In R. Taconis, P. den Brok, & A. Pilot (Eds.), *Teachers creating context-based learning environments in science* (pp. 1-19). Sense Publishers.

*Tağ, M.S. (2019). *Maddenin yapısı ve özellikleri ünitesinin işlenmesinde yaşam temelli öğrenme yaklaşımının etkisi [The effects of the context-based learning approach on the training of the structure and properties of matter unit]* [Unpublished doctoral dissertation]. Fırat University, Elazığ.

Tekbıyık, A. (2010). *Bağlam temelli yaklaşımla ortaöğretim 9. sınıf enerji ünitesine yönelik 5E modeline uygun ders materyallerinin geliştirilmesi [Development of course materials ıntegrating context based approach into 5e model in terms of energy unit for 9th grade secondary students]* [Unpublished doctoral dissertation]. Karadeniz Technical University, Trabzon.

*Tulum, G. (2019). *Fen bilimleri dersi ışık konusuna yönelik geliştirilen bağlam temelli materyalin akademik başarı üzerine etkisi [The effect of context-based material on academic achievement in light science course]* [Unpublished master's thesis]. Ondokuz Mayıs University, Samsun.

*Tütüncü, G. (2016). *Lise 10. sınıf gazlar konusu ile ilgili bağlam temelli yaklaşıma dayalı hikayelerle destekli bir öğretim materyalinin geliştirilmesi ve uygulanması [Development and implementation of a teaching material about high school 10th grade gases topic based on the context-based approach reinforced by stories]* [Unpublished doctoral dissertation]. Karadeniz Technical University, Trabzon.

*Ulusoy, F. M. (2013). *Bağlam temelli öğrenme ile desteklenen bütünleştirici öğrenme modelinin öğrencilerin kimya öğretimine yönelik tutum, motivasyon ve başarılarına etkisi [Effect of generative learning model integrated with context-based learning on students' attitude, motivation and achievement towards chemistry teaching]* [Unpublished master's thesis]. Hacettepe University, Ankara.

*Uzun, F. (2013). *Bağlam temelli yaklaşıma dayalı genel fizik-ı laboratuvar dersinin fen bilgisi öğretmen adaylarının başarılarına, bilimsel süreç becerilerine, motivasyonlarına ve hatırlamalarına etkisi [The effects of context based learning approach on achievement, scientific process skills, motivations and recall of preservice science teachers in general physics laboratory I course]* [Unpublished master's thesis]. Marmara University, İstanbul.

*Ünal, H. (2008). *İlköğretim fen ve teknoloji dersinin yaşam temelli yaklaşıma uygun olarak yürütülmesinin "madde-ısı" konusunun öğrenilmesine etkilerinin araştırılması [Researching the effects of conducting the primary school science and technology lesson according to context based approach on the matter-heat subject]* [Unpublished master's thesis]. Atatürk University, Erzurum.

*Ünal, Ş. (2016). *Biyoloji dersi çevre konularının öğretiminde yaşam temelli yaklaşıma dair örnek olay inceleme ve araştırma sorgulama temelli bilim öğrenme öğretim yöntemlerinin etkisi [The effect of case study and science writing heuristic based method of learning science about life based approach on teaching environmental subjects in biology course]* [Unpublished doctoral dissertation]. Gazi University, Ankara.

Wieringa, N., Janssen, F. J. J. M., & Van Driel, J. H. (2011). Biology teachers designing context-based lessons for their classroom practice: The importance of rules-of-thumb. *International Journal of Science Education, 33*(17), 2437-2462. https://doi.org/10.1080/09500693.2011.553969