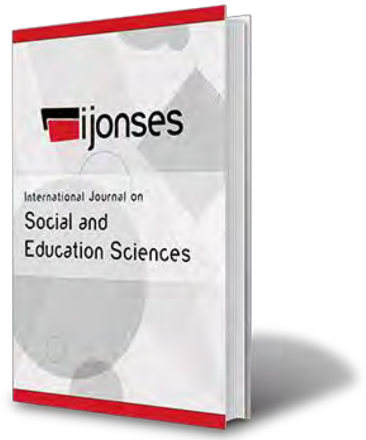


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# A Comparative Meta-Analysis on the Effectiveness of Three Types of Instructional Methods on Language Success

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# A Comparative Meta-Analysis on the Effectiveness of Three Types of Instructional Methods on Language Success

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## Abstract

This study aims to examine the effectiveness of collaborative learning, augmented reality, and learning cycle models on students' language success. This study employed meta-analysis methodologies to examine data derived from 54 studies with a sample size of 2,837 participants in Turkey. The data sources were obtained from online database searches on national and international databases from 2008 to 2022, published in Turkey. Through the random effects model, data analysis was done by Stata software to determine the overall effect size and the heterogeneity of the studies. The findings showed that all instructional methods were positively effective, including collaborative learning (g= 0.895) and augmented reality (g= 0.856), which had a high effect, while the overall effect of learning cycle models (1.485) had an excellent effect on the language success of students. Additionally, in the moderator analysis, there were no significant differences according to the type of publication, target class, sample sizes, or practice time. The investigators found that the significant positive effects were present for all three contemporary instructional methods. Therefore, these findings highlight that the use of the three examined instructional methods has the potential to improve student language achievement, and suggest that teachers should strongly consider implementing collaborative, augmented reality, and learning cycle activities within their language classrooms.

## Introduction

How do students learn languages best? This question has been the focus of early studies in language learning research, which revealed that successful language learners benefit from various factors, including motivation, gender, task type, age, cultural background, and learning style. Subsequent research has shown that, in addition to specific strategies such as communicative language teaching (Solak & Çakır, 2015; Richards & Rodgers, 2014). These factors can significantly impact language learners. Giang & Tuan (2018) emphasized that the effectiveness of language teaching and learning hinges on the strategic choices made by language learners. There are different instructional methods and techniques used in language classes worldwide. These approaches vary from learner-centered and participatory methods to more traditional teacher-centered ones. The effectiveness of these teaching strategies in promoting linguistic success has been a topic of continuous research and discussion (Richards & Rodgers, 2014).

Language learning has been a longstanding focus of educational research worldwide (e.g., Elabdali, 2021; Giang & Tuan, 2018; Ibrahim et al., 2023; Jackie, 2017; Robat, 2021). Similarly, in Turkey, researchers have shown increasing interest in studies related to language acquisition, teaching, and instructional techniques (e.g., Bozkurt & Aydin, 2023; Erden & Eren, 2018; Kanal, 2022; Robat et al., 2021; Sever, 2019; Şimşek & Direkci, 2022). This study undertakes a comprehensive comparative meta-analysis to examine the effectiveness of three distinct instructional methods for achieving language success. To end that, the following aims were addressed:

1. What are the overall effects of each of the three instructional methods (Collaborative learning, augmented reality, learning cycle models) on Language Success?
2. Do the effects of the three instructional methods vary across publication type, target class, sample sizes and practice time as moderators?
3. What is the potential risk of publication bias within the selected studies?

## Literature Review

### Collaborative Learning (CL)

Collaborative learning holds a significant role in education as it has a profound influence on various student capacities, enhancing their performance in cognition, psychology, and social interaction, as well as their success in language learning (Lavasania et al., 2011; Stephen & Rutherford, 2014). Numerous researchers have evaluated the impact of incorporating CL activities into the teaching process. For example, the studies conducted by Bozkurt and Aydin (2023) and Ibrahim et al. (2023) highlight numerous advantages of (CL) in helping students overcome their lack of communicative competence. These benefits extend to enabling students to attain their language education goals, reducing anxiety, and enhancing learner engagement and satisfaction. Furthermore, Hassanein (2018) noted that students exhibit positive attitudes toward CL activities in the language classroom. According to Foncha (2015), CL can enhance language acquisition by engaging students in activities that foster interaction, facilitate knowledge exchange, create powerful learning experiences, boost students' confidence, and encourage reflection.

### Augmented Reality (AR)

In today's world, the rapid evolution of educational technologies has facilitated their seamless integration into classroom settings. With AR in education, teachers and educators can enhance the learning experience, enabling students to acquire knowledge in a more interactive and engaging manner. This, in turn, can lead to improved learner attitudes toward learning and greater academic achievements (López-Belmonte et al., 2023; Yu, 2023). In line with these developments, Ibrahim et al. (2017) believe that there is a strong potential for language learning in AR, particularly due to the improvement shown in sustained recall compared to the traditional approach. This conclusion finds support in the findings of several researchers, including Matin and Mangina (2023) and Shaumiwaty et al. (2022), who have demonstrated that the integration of AR into language learning contributes to improved student learning outcomes. Therefore, Min & Yu (2023) reported that AR can be used to teach various language skills, including vocabulary, pronunciation, grammar, reading, and writing.

### Learning Cycle Models (LCM)

Learning cycle models, such as the 5E model and the 7E learning cycle, have been adopted to incorporate the constructivist approach into the educational process (Mishra, 2023). However, in the context of language learning, Khasanah (2020) confirmed that LCM can be used to enhance language learning by providing a structured approach to instruction. According to Bahadir and Dikmen (2021), this approach emphasizes that knowledge should be subjectively constructed by individuals rather than being passively transferred.

Numerous studies have consistently demonstrated that the LCM emerges as an effective instructional model to address challenges in education. It amplifies student achievement, fosters learning, and remains uninhibited by attitudes (Ateş, 2017; Bayram, 2015; Köksal, 2014; Maskur et al., 2019). In many research studies conducted in science education, it is emphasized that LCM are effective models in the language classroom through teaching linguistic skills such as writing, speaking, grammar, vocabulary, etc. (Kadan, 2020; Rochman, 2015; Tekdemir, 2019; Yalçın, 2020). Considering all of the above, with such a variety of language instructional methods available today, it is important to investigate their impact on language success. This study aims to shed light on the respective impacts of these methods on language success. Through this comparative exploration, we seek to provide valuable insights into the most effective instructional methods for promoting language success. Therefore, it is believed that this investigation will make a valuable contribution to the literature.

This comparative meta-analysis specifically investigates the effects of three contemporary student-centered instructional methods - collaborative learning, augmented reality, and learning cycle models - on learners' language achievement and success. Collaborative learning involves students working together in small groups or teams to accomplish shared goals. Augmented reality integrates digital technology and content into real-world settings for interactive learning. Learning cycle models structure lessons into phases such as exploration, explanation, and expansion to promote constructivist active learning. By systematically compiling and analyzing studies comparing these three methods with more traditional language instruction, this research seeks to quantify and compare their respective effects on indicators of students' language proficiency and skills. The meta-analysis provides much needed empirical evidence on the benefits of these modern techniques over conventional teaching approaches for improving key educational outcomes in language learners.

## Methodology

### Research Model

In this study, a meta-analysis technique was employed as a method. Within the purpose of synthesize the results of experimental studies investigating the effect of CL, AR, and LCM on language success in Turkey. The technique of meta-analysis was initially defined by Glass (1976) as the statistical analysis of the compilation of analytical results obtained from individual studies for the purpose of integrating research results. In other words, meta-analysis is a method that yields us to get the overall effect size by combining the effect size of independent studies on a given topic in the literature (Gucciardi et al., 2021).

## Data Collection

In this study, graduate theses and articles produced between 2008 and 2022 in Turkey were systematically searched using the key concepts of 'collaborative learning,' 'augmented reality,' 'learning cycle,' and 'learning language' in both Turkish and English. The scanning process involved utilizing the Web of Science, Science Direct, Educational Resources Information Center (ERIC), YÖK, ULAKBİM, and Google Scholar databases to access relevant studies. The research data were collected in June-August 2023. After the screening process, a total of 54 studies were included in the analysis. However, studies that did not meet the criteria for the meta-analysis were excluded. The studies subjected to meta-analysis were required to meet the following criteria:

- Conducted in the language learning/teaching area.
- The full text should be accessible.
- The aim of this study is to determine instructional methods’ (CL, AR & LCM) effects on student language success (achievement).
- Includes at least one experimental group with one control group. The experimental group included at least one of the instructional methods in the study (CL, AR & LCM), and traditional teaching was employed in the control group.
- Information on the validity and reliability of the studies should be provided.
- The studies should include statistical data such as sample sizes, standard deviations, and arithmetic means.

As a result of screening which aims to identify which studies meet the inclusion criteria. After excluded studies which are not related with language teaching and selected instructional Methods (collaborative learning, augmented reality & learning cycle models), there are 128 studies left within the framework of the study; 38 studies which are conducted related to research methods not suitable for meta-analysis (qualitative studies, single group, cost study etc.); 15 studies that do not provide enough experimental data to calculate effect sizes; 8 studies that use other variables as the dependent variable rather than language success (attitude, motivation, etc). 2, 3 and 4 studies that do not have meeting the inclusion criteria of language of study, accessible to study and year of study, respectively. In the end, there are 4 studies that were excluded due to repetition (where the thesis was weighted over the article).

The PRISMA flowchart diagram (Page et. al., 2020) viewing the process of literature review of the studies was included meta-analysis is given in Figure 1. As depicted in the PRISMA Flow Diagram, effect size values for language success were calculated based on 54 different studies (refer to Appendices 2-4). These values were obtained from a total of 23 studies on the Collaborative Learning (CL) method, 17 studies on the Augmented Reality (AR) method, and 14 studies on Learning Cycle Models (LCM).

## Coding Process, Validity & Reliability

After determining the study sample, the researchers prepared a coding form based on the questions and moderator variables of the study. A coding form was developed by the researchers. The coding form of the studies consisted of "study ID content" and "study data" information. The "study ID" was contained information such as study ID number of studies, the name of the studies, the author or authors' name of the studies, published year of studies, publication type of studies, the language of studies, the outcome measures of studies, practice time of studies and students' grade level of studies are used to identify the identification of studies. The "study data" was embodied information about sample size (N), the arithmetic average (X) and standard deviation values (Ss) derived from experimental and control groups from the studies were determined.

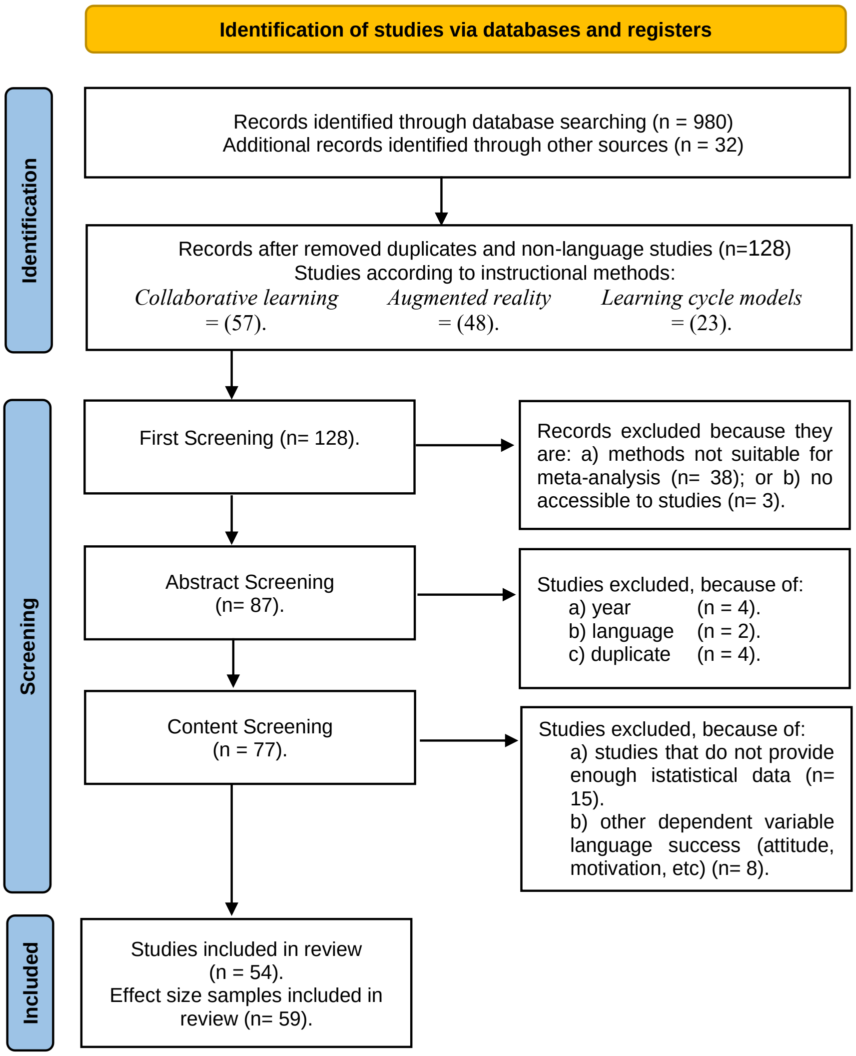


Figure 1. Procedures Performed for the Research Process by PRISMA Flow Diagram

In the light of foregoing, the reliability of the coding process was investigated. In this study, the coding process was conducted by the first investigator who recoded all the studies included in the meta-analysis at an interval of three weeks. For the dependability coefficient calculation, it was benefited from Miles and Huberman's (1994) formula, Reliability = Consensus / (Consensus + Disagreement) 100. According to formula, the reliability rate was calculated as 94%. This rate indicates that the encoding is reliable. Overall, the study's coding process was rigorous and transparent, which enhances the validity and reliability of the findings.

### Data Analysis and Interpretation

To answer the research questions and calculate effect sizes (Hedges' g), appropriate formats were selected for the arithmetic average (X), standard deviations (Ss), sample sizes (N), and test statistics of the control and experiment groups. In order to determine which model should be employed in this study, the heterogeneity test (Q & $I^2$) was performed, according to results, the analysis was included in random effects model. Whereas, if the distribution of effect sizes is heterogeneous, the random effects model should be used (Ellis, 2010). In the study, moderator testing was carried out only when there was at minimum 2 studies per category.

Although the large heterogeneity obtained in two of the three instructional methods in the study, it was unexpected (similar reviews on the topic of instructional methods reported large heterogeneity too; e.g., DeSmet et al., 2014 and Granic et al., 2014). It undoubtedly restricts how the results we got should be interpreted. In this study, the high heterogeneity is most probably due to the high differentiation of the effect size between studies and the difference language skills contained in the studies. The large heterogeneity was the reason for the emergence of some evidence of the small study effects of Egger and Begg Publication Bias testing. To measure the resistance strength of the results of the meta-analysis, the Fail-Safe N and fill and trim tests were performed. The Thalheimer & Cook (2002) classification was used to interpret the effect sizes in the study.

In this meta-analysis study, Stata software was used to examine overall effect size, moderator analysis, publication bias, drawing the forest and funnel plot graphs. Besides, the descriptive data analyses and Fail-Safe N calculated were done by Microsoft Excel 365 software.

## Results

### Descriptive Statistics

In the current meta-analysis study researching the effectiveness of three distinct instructional methods in achieving language success in Turkey, the general characteristics of 54 examined studies and their respective effect sizes were determined. During the data analysis, moderators were employed to investigate the relationships between effect sizes and study characteristics, such as type of publication, target class, sample size, and practice time.

### Meta-Analysis Model and General Effect Size Results

The first research question aimed to determine the overall effects of each of the three instructional methods (collaborative learning, augmented reality, and learning cycle models) on language success. Out of 54 primary studies conducted from 2008 to 2022, involving 2,837 participants, effect sizes (Hedges' g) were collected for meta-analysis. Initially, it is crucial to identify the meta-analysis model for calculating the study's effect size. The first step involves testing the homogeneity of the studies using meta-analysis models. The results regarding the homogeneity of the studies and the general effect size are presented in Table 1.

In this study, based on the homogeneity test (Q) and $I^2$ statistic, the model was included in the effects model by calculating the variance of the random model component because the sampling errors-induced homogeneity test resulted in a larger value than expected. Overall, the use of a random effects model in this study was justified based on the significant heterogeneity among the included studies. The heterogeneity analysis provided evidence that a fixed effects model would not be appropriate, and the use of a random effects model allowed for a more accurate estimation of the true effect size by accounting for the heterogeneity among the studies.

Table 1. Finding of the Effect Size Based on the Random Model

| Moderator Methods | N | (ES) | (df) | (Q) | (Chi-Squar) | (SE) | I2 | (ES (%95 CI)) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | (Min.) | (Max.) |
| CL | 23/27 | 0.895 | 26 | 86.83 | 38.885 | 0.11 | 73.19 | 0.682 | 1.108 |
| AR | 17/18 | 0.856 | 17 | 123.53 | 27.587 | 0.18 | 87.11 | 0.512 | 1.200 |
| LCM | 14 | 1.485 | 13 | 98.01 | 22.362 | 0.27 | 90.65 | 0.943 | 2.027 |

The results of the CL method of the meta-analysis conducted which based on the random effects model indicated that the average effect size was 0.895 with 0.11 errors, the upper limit of the 95% confidence interval was 1.108 and the lower limit was 0.682. On the other hand, the average effect size of the AR method was calculated as 0.856 with 0.18 errors as a result of the analysis done according to random effects model. The upper bound of the effect size is 1.200 and lower bound is 0.512 in 95 % confidence interval.

Concerning the average effect size of the LCM was calculated as 1.485 with 0.27 errors as a result of the analysis done according to random effects model. The lower bound of the effect size is 0.943 and upper bound is 2.027 in 95 % confidence interval. Based on the Thalheimer and Cook classification (2002), the effect size of CL and AR method are high, while the effect size of LCM is excellent on teaching language processes. A forest plot for the meta-analysis was generated to assess the effect sizes of the CL, AR and LCM studies included in the analysis. Please refer to Appendices 2, 3, and 4 for more details.

## The Effect Size of the Studies According to the Moderator

For the second research question, the aim was to investigate the moderating factors of the three instructional methods on language success. We explored the impact of moderating variables (publication type, target class, sample sizes, and practice time) on the overall effectiveness of the three instructional methods on language success. Detailed information is presented in Tables 2-5.

*Results about Problem of Types of Publication*

The result of moderator analysis for publication type is given in Table 2. The type of publication of the instructional methods studies was examined as a moderating variable in the study, as shown in Table 2. According to table, the heterogeneity value publication type of the CL method (QB=2.50, df=2, p=0.287), that of AR reality (QB=1.78, df=2, p=0.410) and that of LCM method (QB=1.20, df=2, p=0.550) are smaller than the critical chi-square values which indicates that there is no statistically significant difference between the instructional methods on language success in level of publication types. In other words, student language success in CL, AR, and LCM does not differ according to the type of publication.

Table 2. Effect Size Moderators: Types of Publication

| Methods | Variable Type of Publication | Inter-Group Homogeneity Value (QB) | df | P | N | ES | ES (%95 CI) Minimum Value | Maximum Value | Standard Error (SE) |
|---|---|---|---|---|---|---|---|---|---|
| CL | | 2.50 | 2 | 0.287 | 27 | 0.897 | | | |
| | PhD Thesis | | | | 6 | 0.603 | 0.120 | 1.085 | 0.25 |
| | MS Thesis | | | | 16 | 0.961 | 0.656 | 1.265 | 0.16 |
| | Article | | | | 5 | 1.053 | 0.769 | 1.336 | 0.14 |
| AR | | 1.78 | 2 | 0.410 | 18 | 0.856 | | | |
| | PhD Thesis | | | | 2 | 1.183 | 0.687 | 1.680 | 0.25 |
| | MS Thesis | | | | 9 | 0.640 | 0.004 | 1.277 | 0.32 |
| | Article | | | | 7 | 1.029 | 0.751 | 1.307 | 0.14 |
| LCM | | 1.20 | 2 | 0.550 | 14 | 1.485 | | | |
| | PhD Thesis | | | | 4 | 1.156 | 0.268 | 2.044 | 0.48 |
| | MS Thesis | | | | 5 | 1.896 | 0.879 | 2.913 | 0.52 |
| | Article | | | | 5 | 1.355 | 0.410 | 2.300 | 0.45 |

*Results about Problem of Target Class in Studies*

The result of moderator analysis for target class is given in Table 3. The target class of the instructional methods studies was examined as a moderating variable in the study, as shown in Table 3. According to the results the heterogeneity value of the target class of the CL method (QB=0.20, df=1, p=0.657), that of AR method (QB=1.04, df=1, p=0.308) and that of LCM method (QB=0.08, df=1, p=0.776) are smaller than the critical chi-square values which indicates that there is no statistically significant difference between the instructional methods on language success in level of target class. In other words, student language success in the CL, AR, and LCM models does not differ according to the target class.

Table 3. Effect Size Moderators: Target Class

| Methods | Variable Target Class | Inter-Group Homogeneity Value (QB) | df | P | N | ES | ES (%95 CI) Minimum Value | Maximum Value | Standard Error (SE) |
|---|---|---|---|---|---|---|---|---|---|
| CL | | 0.20 | 1 | 0.657 | 27 | 0.897 | | | |
| | Turkish | | | | 15 | 0.904 | 0.643 | 1.166 | 0.20 |
| | Foreign-Language | | | | 12 | 0.887 | 0.501 | 1.273 | 0.20 |
| AR | | 1.04 | 1 | 0.308 | 18 | 0.856 | | | |

| Methods | Variable<br>Target Class | Inter-Group Homogeneity Value (QB) | df | P | N | ES | ES (%95 CI) Minimum Value | Maximum Value | Standard Error (SE) |
|---|---|---|---|---|---|---|---|---|---|
| | Turkish | | | | 8 | 0.647 | 0.032 | 1.261 | 0.31 |
| | Foreign-Language | | | | 10 | 1.022 | 0.644 | 1.400 | 0.19 |
| LCM | | 0.08 | 1 | 0.776 | 14 | 1.485 | | | |
| | Turkish | | | | | 1.451 | 0.701 | 2.200 | 0.38 |
| | Foreign-Language | | | | | 1.579 | 1.103 | 2.056 | 0.24 |

*Results about Problem of Sample Sizes of Studies*

The result of moderator analysis for sample sizes is given in Table 4.

Table 4. Effect Size Moderators: Sample Sizes

| Methods | Variable<br>Sample Size | Inter-Group Homogeneity Value (QB) | df | P | N | ES | ES (%95 CI) Minimum Value | Maximum Value | Standard Error (SE) |
|---|---|---|---|---|---|---|---|---|---|
| CL | | 3.71 | 1 | 0.054 | 27 | 0.897 | | | |
| | 1≤N≤50 | | | | 9 | 1.219 | 0.809 | 1.629 | 0.12 |
| | 51≤N | | | | 18 | 0.756 | 0.525 | 0.987 | 0.12 |
| AR | | 3.09 | 1 | 0.079 | 18 | 0.856 | | | |
| | 1≤N≤50 | | | | 4 | 1.281 | 0.832 | 1.731 | 0.23 |
| | 51≤N | | | | 14 | 0.740 | 0.337 | 1.143 | 0.21 |
| LCM | | 3.00 | 1 | 0.083 | 14 | 1.485 | | | |
| | 1≤N≤50 | | | | | 1.870 | 1.125 | 2.615 | 0.38 |
| | 51≤N | | | | | 1.010 | 0.384 | 1.636 | 0.32 |

The sample size of the instructional methods studies was examined as a moderating variable in the study, as shown in Table 4. According to the results, the heterogeneity value of the sample size of the CL learning method (QB=3.71, df=1, p=0.054), that of AR reality method (QB=3.09, df=1, p=0.079) and that of learning cycle models method (QB=3.00, df=1, p=0.083) are smaller than the critical chi-square values, which indicates that there is no statistically significant difference between the instructional methods on language success in level of sample size. In other words, student language success in CL, AR, and LCM does not differ according to the sample size.

*Results about Problem of Practicing Time of Studies*

The result of moderator analysis for practicing time is given in Table 5.

Table 5. Effect Size Moderators: Practicing Time

| Methods | Variable P.T. (Week) | Inter-Group Homogeneity Value (QB) | df | P | N | ES | ES (%95 CI) Minimum Value | Maximum Value | Standard Error (SE) |
|---|---|---|---|---|---|---|---|---|---|
| CL | | 0.19 | 1 | 0.662 | 27 | 0.897 | | | |
| | 1≤W≤5 | | | | 13 | 0.845 | 0.516 | 1.174 | 0.17 |
| | 6≤W | | | | 14 | 0.945 | 0.641 | 1.249 | 0.16 |
| AR | | 0.25 | 1 | 0.614 | 18 | 0.856 | | | |
| | 1≤W≤5 | | | | 12 | 0.912 | 0.440 | 1.385 | 0.24 |
| | 6≤W | | | | 6 | 0.742 | 0.282 | 1.203 | 0.24 |
| LCM | | 0.43 | 1 | 0.511 | 14 | 1.485 | | | |
| | 1≤W≤5 | | | | | 1.268 | 0.808 | 1.728 | 0.23 |
| | 6≤W | | | | | 1.530 | 0.899 | 2.161 | 0.32 |

The practicing time of the instructional methods studies was examined as a moderating variable in the study, as shown in Table 5. According to the results, the heterogeneity value of the practicing time of the CL method (QB=0.19, df=1, p=0.662), that of AR method (QB=0.25, df=1, p=0.614) and that of learning cycle models method (QB=0.43, df=1, p=0.511) are smaller than the critical chi-square values, which indicates that there is no statistically significant difference between the instructional methods on language success in level of practicing time. In other words, student language success in CL, AR, and LCM does not differ according to the practice time.

**Publication Bias**

The third research question aimed to identify the potential risk of publication bias within the selected studies. To underscore the crucial significance of the resulting common effect size in this study, publication bias was assessed using funnel plots, fill and trim tests, Egger tests, and fail-safe N based on Rosenthal. The overall effect test of the three types of instruction methods showed that the learning effect was significantly improved after the application of CL, AR, and LCM models to language learning. The funnel plot illustrating the publication bias of the instructional method studies is presented in Figure 2-5.

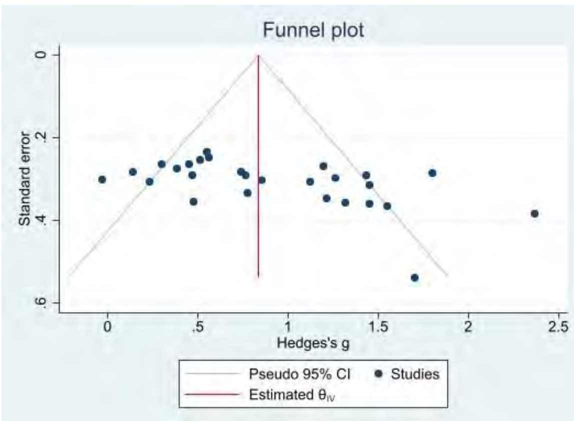


Figure 2. CL Funnel Plots

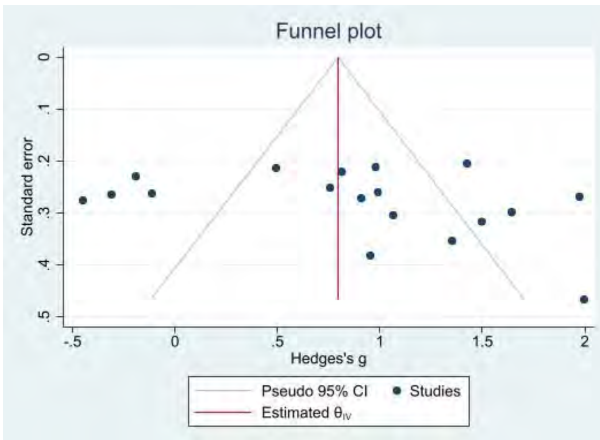


Figure 3. AR Funnel Plots

As seen in the figures, funnel plots were created to investigating publication bias. The publication bias diagram one robust technique to observed effect size against standard error. A funnel plot is a scatter plot of the estimated effect sizes from the meta-analysis studies relative to the standard error (Stern & Egger, 2001). As seen in the figures, a visual survey of the publication bias diagram generated from the present meta-analysis indicates generally symmetrical distributions roughly the weighted mean effect sizes with a few outliers (see Figure 5).

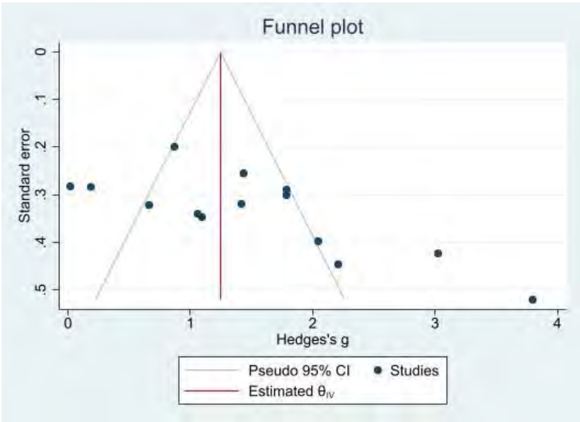


Figure 4. LCM Funnel Plots

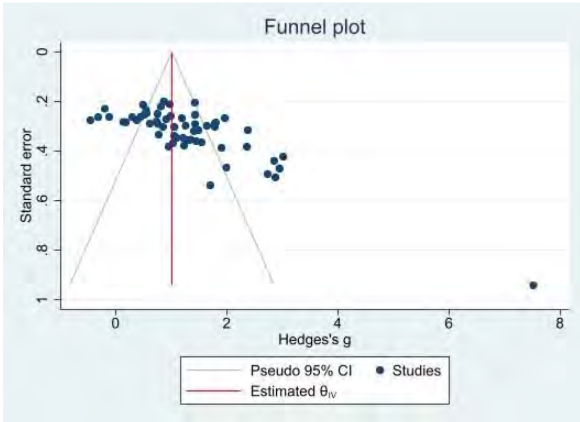


Figure 5. Three Methods Funnel Plots

*The Result of Egger Test:*

Another test for investigating the publication bias of the meta-analysis results, is the Egger's test. The publication bias of studies which deal with CL, AR and LCM on language success were examined through Egger Test. The obtained findings are given in Table 6. When Table 6 is reviewed, it is observed that in the method of augment reality the estimated slope is 4.54 with a standard error of 2.690 giving a test statistic of $z = 1.69$ and a p-value of 0.0913. This means that there is no evidence of small study effects. While in methods of CL & LCM, it was observed the estimated slope are 5.85, 9.13 with a standard error of 1.858, 2.288, giving a test statistic of $z = 3.15$, 3.99 and a p-value of 0.0016, 0.0001, respectively. Thus, we reject the null hypothesis of no small study effects. In another word, this means there is some evidence of small study effects.

Table 6. Egger's Linear Test Calculations

| | CL | AR | LCM |
|---|---|---|---|
| Estimated slope | 5.85 | 4.54 | 9.13 |
| Standard error | 1.858 | 2.690 | 2.288 |
| z-test | 3.15 | 1.69 | 3.99 |
| P-value | 0.0016 | 0.0913 | 0.0001 |

*The Result of Begg Test*

Another test for investigating the small study effects of the meta-analysis results is the Begg test. The publication bias of the studies which deal with CL, AR and LCM on language success was examined through Begg Test. The obtained results are given in Table 7.

Table 7. Begg Test Calculations

| | CL | AR | LCM |
|---|---|---|---|
| Kendall's score | 131.00 | 19.00 | 49.00 |
| Standard error | 47.969 | 26.401 | 18.267 |
| z-test | 2.71 | 0.68 | 2.63 |
| two-sided p-value | 0.0067 | 0.4954 | 0.0086 |

When we look at the results of the Begg test, it is observed that in the AR method, the Kendall's score is 19.00 with a standard error of 26.401 giving a test statistic of z = 0.68 and a p-value of 0.4954. This means that there is no evidence of small study effects. While in the CL and LCM methods, it is observed that Kendall's score is 131.00, 49.00 with a standard error of 47.969, 18.267, giving a test statistic of z = 2.71, 2.63 and a p-value of 0.0067, 0.0086, respectively. Therefore, this means that there is some evidence of small study effects.

*The Result of Fill and Trim Test:*

The fill and trim test is another way to examine publication bias in meta-analysis studies. The publication bias of the studies which deal with CL, AR, and LCM on language success was examined through fill and trim test. The obtained findings are given in Table 8.

Table 8. The Result of Fill and Trim Test

| | Studies Trimmed | Hedges's g | Random Effect Model | |
|---|---|---|---|---|
| | | | 95%CI | Hedge's g |
| CL | 27 | | | |
| Observed | 27 | 0.897 | 0.677 | 1.117 |
| Adjusted | 0 | 0.897 | 0.677 | 1.117 |
| AR | 21 | | | |
| Observed | 18 | 0.856 | 0.512 | 1.200 |
| Adjusted | 3 | 0.671 | 0.305 | 1.036 |
| LCM | 14 | | | |
| Observed | 14 | 1.485 | 0.944 | 2.027 |
| Adjusted | 0 | 1.485 | 0.944 | 2.027 |

According to the trim and fill test developed by Duval and Tweedie (2000), there is no evidence of missing studies effected on the effect size on methods of AR and LCM. In another hand, there is 3 missing studies (based on a random effect model) that would have reduced the mean ES to 671, 95% CI= [0.305; 1.036] in the AR method. The estimated mean ES remain is similar to the original one, and still significant. Accordingly, it can be stated that the effect size determined by the present meta-analysis is resistant to publication bias.

*The Results Fail-Safe N:*

The value of the Rosenthal fail-safe number (FSN) is determined to ensure that there was no publishing bias. Table 9 presents the results.

Table 9. The Results Fail-Safe N

| Instructional Methods | N total | Sum z total | Fail Safe N Total |
|---|---|---|---|
| CL | 27 | 81.59 | 2433.22 |
| AR | 18 | 55.73 | 1130.03 |
| LCM | 14 | 60.92 | 1357.65 |

According to Rosenthal's fail-safe N test findings, the number of studies required to reduce the overall effect size of CL, AR, and LCM (Es=0.897, 0.856 and 1.485 for a random effect model) to the level of ineffectiveness, Es=0.00, to reduce. This result is 2433, 1130 & 1357 studies related to this study, respectively. Accordingly, it can be stated that the overall effect size obtained through the present meta-analysis is resistant to publication bias.

## Discussion

The results of this meta-analysis are discussed in relation to the three research questions previously mentioned, starting with the first research inquiry, which estimate the overall effectiveness of CL, AR, and LCM methods on students' language success. We observed a significantly large positive effect size for both the CL method ($g=0.895$) and the AR method ($g=0.856$), indicating high effectiveness, while the LCM method yielded an excellent overall effect ($g=1.485$) on students' language achievement based on Thalheimer and Cook's (2002) interpretation ($0.75 \leq g < 1.10$ for high, $g \geq 1.45$ for excellent). Taken as a whole, this conclusion aligns with the findings of previous research conducted by Alacapınar and Uysal (2020) and Ramdani et al. (2022). These studies asserted that CL method have a positive impact on students' academic achievement across various grade levels and subject domains when compared to traditional methods. Several other meta-analyses were conducted by Chang et al. (2022), Garzón et al. (2020), and Yu (2023) focusing on the efficiency of AR applications in education. Moreover, in line with researches conducted by Bahadir and Dikmen (2022), Cakır (2017), and Sarac (2018), it has been established that students achieve enhanced learning outcomes when exposed to LCM, as evidenced by improved success rates, retention levels, and attitude scores toward the subject.

By addressing the first inquiry, our endeavor involved providing a response to the longstanding query, "How do students learn languages best?" (see, e.g., Budiyanto, 2020; Chang, 2017, etc.). This was achieved through the utilization of three teaching methodologies that were informed by an extensive analysis of literature spanning a period of almost 14 years within the Turkish context. However, in this research, it has been revealed that the collaborative learning method increases the language success of students. This result of the study coincides with the conclusion that the collaborative learning approach has a positive effect on the academic achievement of the students in Turkish courses, in comparison with the traditional methods of Kaldırım and Tavsanlı (2018). It also aligns with the results of a meta-analysis study conducted by Elabdali (2021); it has been established that collaborative learning activities increase students' language success in the learning process compared to individual methods. On the other hand, the finding that the use of augmented reality (AR) applications led to greater improvements in students' language proficiency aligns with the findings of Alshumaimeri and Mazher (2023), who found that AR technology is an effective tool for both teaching and learning and is particularly beneficial during the early stages of education. Additionally, the research of Cai et al. (2022) provides support for the effectiveness of AR applications in facilitating language acquisition among learners. Furthermore, our investigation was grounded in the examination of various studies. Furthermore, no meta-analysis studies have been conducted to explore learning cycle models in Turkey with regards to language learning. The findings of the present meta-analysis on learning cycle models are similar to several studies carried out by Boggu and Sundarsingh (2016) and Seçer and Yücel-Toy (2020), which posit that the implementation of the 5E Learning based Essay positively impacts the level of language achievement. It is noteworthy that the 5E strategy alters the teacher's function from being just prompter to that of a mentor and guide, which empowers students in their learning expedition and consequently enhances their academic accomplishments. One possible explanation for the excellent effect of learning cycle models could be the compatibility between the activities of the CLM method and the educational curricula applied in Turkey. Whereas, the Ministry of National Education (MoNE) has adopted a constructivist approach to education (Sarac, 2018).

With regard to the second question, four major of moderators, including types of publication, target class, sample sizes, and practicing time were meta-analyzed in our study. The meta-analysis examines moderators influencing variable relationships, explaining effect size diversity and intervention effectiveness. Interaction effects among moderators are vital (María, 2020; Li, 2020). As we mentioned it earlier, moderator analysis was carried out only when there was at minimum 2 studies per category. The results of moderator analysis, it has been reinforce that the results were deemed non-significant across all four moderators separately, with respect to all methods of language instruction. This trend may indicate that though those variables had added value in teaching, it was not statistically significant to affect the overall effect. Accordingly, it has been concluded that the trend identified may provide insight into the notion that while variables may have contributed to the teaching process, their statistical significance was not substantial enough to impact the overall outcome.

In the light of third inquiry, a review of publication bias helps to ensure that a sizable number of studies that would have been included in the analysis were missing (Borenstein et al., 2005; Sutton, 2009). As well as our results have to be treated with extreme caution due to the nature of meta-analysis studies, which are vulnerable to publication bias. In our study, to detect if publication bias affected the study results, the researchers used funnel plots, Egger's linear test, Begg test, fill and trim test, and Fail-Safe N methods to evaluate publication bias. The assessment of publication bias suggests that there may be some degree of publication bias present in these studies. The null hypothesis of small-study effects was rejected in a method of collaborative learning and learning cycle models, because the p-value of the Egger and Begg test is less than $p<0.05$. One of the more revealing aspects of meta-analysis is the relation between effect sizes and moderator variables. Interestingly moderator variables are generally related to each other and to effect sizes (lipsey, 2003). To investigate the reason behind the small-study effects, the moderator regression-based test was employed for different monitors (types of publication, target class, sample sizes, practicing time, method & effect size of studies). As a result of this analysis, the reason behind the small study was heterogeneity of included studies or other reasons in the studies moderator. Additionally, in order to assess the robustness of the findings of the meta-analysis, the researchers conducted both the Fail-Safe N and the fill and trim tests, which are commonly used methods in this context. Accordingly, it can be stated that the effect size determined by the present meta-analysis is resistant to publication bias. Furthermore, the fact that these results, especially those related to collaborative learning and augmented reality, concur with other meta-analysis studies that contained an impact size comparable to the results of this study (e.g., Alshumaimeri & Mazher, 2023; Cai et al., 2022; Elabdali, 2021; Kaldrm & Tavsanl, 2018) strengthens their reliability.

As a nascent discipline, there are few but rising comparisons between meta-analytic results from language studies (e.g., Cook, 2012; Faules et al., 1972; Plonsky, 2011; Robat et al., 2021). According to Higgins (2016), the comparative meta-analysis, compares effects between different kinds of interventions of approaches studies or between meta-analyses. The key point here, although meta-analysis is a powerful comparative effectiveness strategy, methodological challenges and limitations in primary research must be acknowledged to interpret findings (Conn et al., 2012). When we looked into this type of research during the analysis process, it pointed to two challenges, as we mentioned earlier: firstly, all teaching methods were effective, and secondly, the contexts were very heterogeneous (Robat et al., 2021).

Finally, research is needed to better understand the effect of different instructional methods and process variables on teaching language processes. For a number of years, several experts immersed in the field of language teaching methodologies have endeavored to devise the ultimate pedagogical approach that can yield the most optimal outcome in language acquisition, be it as a secondary or non-native language (Ayiz, 2014). Additionally, the proliferation of novel telecommunication technologies, internet accessibility and velocity, artificial intelligence, voluminous data, learning analytics, intelligent applications, and online translation amenities, among other advancements, on one side, and the dynamic engagement and rivalry of the private sector in the language instruction domain, on the other side, in conjunction with the influences stemming from globalization patterns, have instigated substantial transformations in language instruction approaches. The need for empirical and investigative research in this field was born. What we found based on the literature of almost a fourteen year of language teaching is in line with several researchers argued this inquiry (e.g., Kalia, 2017; Robat et al., 2021). In the final analysis, Perhaps it is important that when answering the question “what are the most effective approaches for enhancing language acquisition among students” that each language teaching context is unique. Language teaching methods vary based on context and learner’s needs, with effectiveness varying based on individual preferences. Tailoring methods to local situations and learning objectives is crucial, with the ultimate goal of enabling practical language usage (see, e.g., Pettengill, 2022; Gang & Xiaochun, 2015; Kalia, 2017).

## Conclusion

On the whole, it can be concluded that rather than restricting student’s language learning to traditional instructional strategies, the introduction of contemporary teaching strategies such as collaborative learning, augmented reality, and learning cycle models will significantly aid students in their efforts to learn languages. Nonetheless, researchers and practitioners are encouraged to engage in further investigations and explorations to comprehend the contextual and conditional factors that determine the efficacy of each approach.

The present meta-analysis investigation was restricted to studies disseminated within the timeframe of 2008 to 2022 within the geographical boundaries of Turkey. Subsequent research endeavors may elect to incorporate studies divulged under different restrictions. In this direction, Teachers could use the following strategies to give pupils deeper personalized instruction in language teaching by using the study's findings: Think about looking into the advantages of integrating two or more teaching techniques (Kaplan, 2019). Can learning cycle models be connected with cooperative group tasks, for instance, or can collaborative learning be improved with augmented reality components? (see, e.g., Asquith, 2022; and Wen, 2021). The author proposes the implementation of targeted investigations into language skills to monitor the impact of the proposed methods on the linguistic accomplishments of students over a prolonged period.

## Notes

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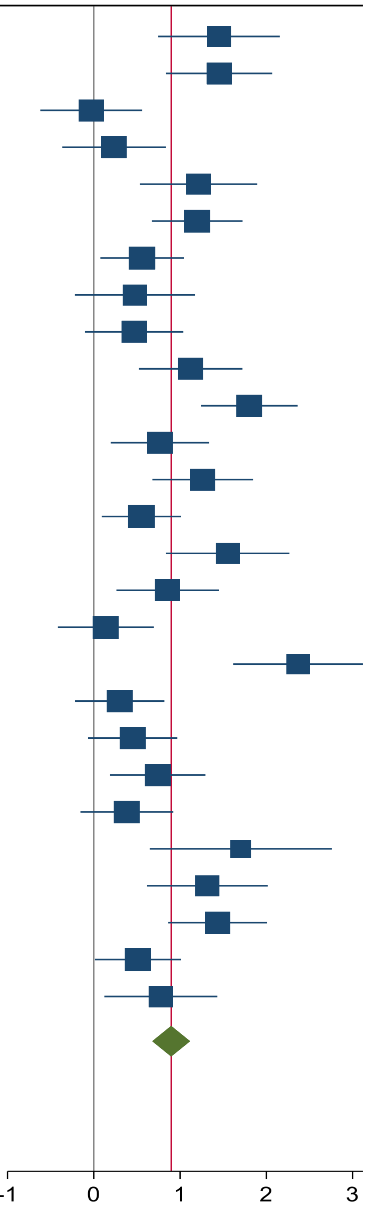
## Appendix 1. The Forest Plot Figures of the CL Method

| Study | 95% CI | SE | Hedges's g |
|---|---|---|---|
| (Akbaş, 2017) | [ 0.75, 2.16] | 0.36 | 1.45 |
| (Altay, 2022) | [ 0.84, 2.07] | 0.31 | 1.45 |
| (Aşık, 2018)A | [-0.62, 0.56] | 0.30 | -0.03 |
| (Aşık, 2018)B | [-0.37, 0.83] | 0.31 | 0.23 |
| (Baş, 2009) | [ 0.53, 1.89] | 0.35 | 1.21 |
| (Baş, 2012) | [ 0.67, 1.72] | 0.27 | 1.20 |
| (Batdı, 2013) | [ 0.08, 1.05] | 0.25 | 0.56 |
| (Büker, 2019)A | [-0.22, 1.17] | 0.36 | 0.48 |
| (Büker, 2019)B | [-0.10, 1.04] | 0.29 | 0.47 |
| (Büker, 2019)C | [ 0.52, 1.72] | 0.31 | 1.12 |
| (Çalhan, 2012) | [ 1.24, 2.36] | 0.29 | 1.80 |
| (Dilek, 2010) | [ 0.20, 1.34] | 0.29 | 0.77 |
| (Erden and Eren, 2018) | [ 0.68, 1.85] | 0.30 | 1.26 |
| (Erden, 2020) | [ 0.09, 1.01] | 0.23 | 0.55 |
| (Karabuğa, 2012) | [ 0.84, 2.27] | 0.37 | 1.55 |
| (Karakoyun, 2010) | [ 0.26, 1.45] | 0.30 | 0.86 |
| (Kartal, 2014) | [-0.42, 0.69] | 0.28 | 0.14 |
| (Kil, 2019) | [ 1.62, 3.12] | 0.38 | 2.37 |
| (Sever, 2019)A | [-0.22, 0.82] | 0.26 | 0.30 |
| (Sever, 2019)B | [-0.07, 0.97] | 0.26 | 0.45 |
| (Soylu, 2008) | [ 0.19, 1.29] | 0.28 | 0.74 |
| (Sönmez, 2020) | [-0.16, 0.92] | 0.27 | 0.38 |
| (Tanrıverdi, 2019) | [ 0.65, 2.76] | 0.54 | 1.70 |
| (Ulaş et al., 2015) | [ 0.62, 2.02] | 0.36 | 1.32 |
| (Uslu, 2019) | [ 0.86, 2.01] | 0.29 | 1.44 |
| (Yılmaz and Top, 2015) | [ 0.01, 1.01] | 0.25 | 0.51 |
| (Yılmaz, 2019) | [ 0.12, 1.43] | 0.33 | 0.78 |
| **Overall** | [ 0.68, 1.12] | 0.11 | 0.90 |




Heterogeneity: $\tau^2 = 0.25$, $I^2 = 73.19\%$, $H^2 = 3.73$

Test of $\theta_i = \theta_j$: $Q(26) = 86.83$, $p = 0.00$

Test of $\theta = 0$: $z = 7.98$, $p = 0.00$

Random-effects Hedges model

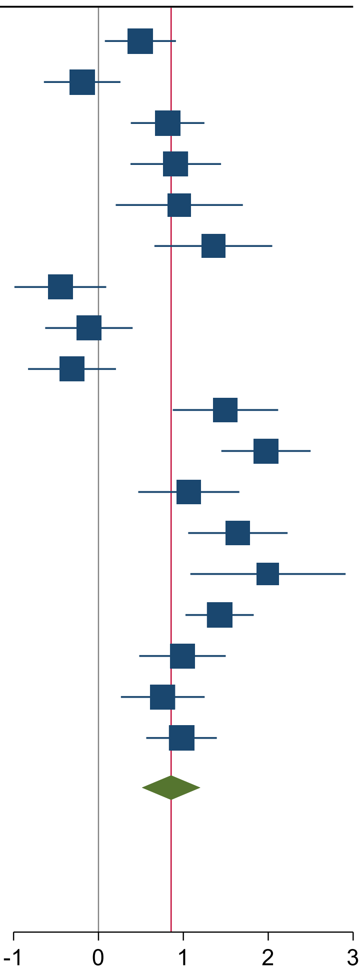
## Appendix 2. The Forest Plot Figures of the AR Method

| Study | 95% CI | SE | Hedges's g |
|---|---|---|---|
| (Akçayir and Akçayir, 2016) | [ 0.08, 0.91] | 0.21 | 0.49 |
| (Bahadir, 2019) | [-0.64, 0.26] | 0.23 | -0.19 |
| (Bursali and Yilmaz, 2019) | [ 0.38, 1.25] | 0.22 | 0.81 |
| (Çakır et al., 2015) | [ 0.38, 1.44] | 0.27 | 0.91 |
| (Çevik et al., 2017) | [ 0.20, 1.70] | 0.38 | 0.95 |
| (Doğan, 2016) | [ 0.66, 2.05] | 0.35 | 1.35 |
| (Kanal, 2020) | [-0.99, 0.09] | 0.28 | -0.45 |
| (Özbek, 2018) | [-0.63, 0.40] | 0.26 | -0.11 |
| (Özbek, 2018)B | [-0.83, 0.21] | 0.26 | -0.31 |
| (Özdemir, 2019) | [ 0.88, 2.12] | 0.32 | 1.50 |
| (Parlar, 2022) | [ 1.45, 2.50] | 0.27 | 1.97 |
| (Sahin and Ozcan, 2019) | [ 0.47, 1.66] | 0.30 | 1.06 |
| (Solak and Cakir, 2015) | [ 1.06, 2.23] | 0.30 | 1.64 |
| (Şahin, 2019) | [ 1.08, 2.91] | 0.47 | 2.00 |
| (Şimşek and Direkçi, 2022) | [ 1.02, 1.83] | 0.21 | 1.43 |
| (Tandoğan, 2019) | [ 0.48, 1.50] | 0.26 | 0.99 |
| (Yıldırım, 2019) | [ 0.26, 1.25] | 0.25 | 0.76 |
| (Yılmaz, 2014) | [ 0.56, 1.39] | 0.21 | 0.98 |
| **Overall** | [ 0.51, 1.20] | 0.18 | 0.86 |

Heterogeneity: $\tau^2 = 0.47$, $I^2 = 87.11\%$, $H^2 = 7.76$

Test of $\theta_i = \theta_j$: $Q(17) = 123.53$, $p = 0.00$

Test of $\theta = 0$: $z = 4.88$, $p = 0.00$




Random-effects Hedges model

## Appendix 3. The Forest Plot Figures of the LCM Method