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Research Article

The effect of vocabulary development interventions on cognitive outcomes of vocabulary: A meta-analysis study

Nurbanu Kansızoğlu[1] and Nazan Bekiroğlu[2]

[1]*Trabzon University, Türkiye (ORCID: 0000-0002-6908-2644)*
[2]*Trabzon University, Türkiye (ORCID: 0000-0001-7067-6215)*

This study aims to assess the overall impact of vocabulary development interventions on cognitive vocabulary outcomes. To achieve this, 43 theses on vocabulary teaching, each involving a specific intervention, were analyzed using meta-analysis. The findings from the meta-analysis, based on the random effects model, indicated that the average effect of vocabulary development interventions on vocabulary outcomes was 1.179. The results demonstrate that interventions designed to enhance vocabulary are significantly more effective than traditional teaching methods in improving students' vocabulary. Furthermore, subgroup and meta-regression analyses revealed that none of the five moderators (pilot study, retention test, method of vocabulary selection, vocabulary outcome [dependent variable], and number of vocabulary items taught) had a significant effect on explaining the heterogeneity in effect sizes. However, the meta-regression results based on the random effects model indicated that the third model, which attempted to explain the variance in effect sizes through sample size and the number of vocabulary items taught, was significant. This model accounted for 44.7% of the variance between studies, explained by the sample size and the number of vocabulary items taught.

Keywords: Cognitive outcomes; Türkiye; Vocabulary; Vocabulary instruction

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1. Introduction

Vocabulary is an important indicator of general verbal ability, which is fundamental for learning (Blachowicz et al., 2006). It is also the strongest predictor of reading comprehension, a vital component of academic success (Beck et al., 2002). A well-developed vocabulary is widely recognized as a key factor distinguishing children who become proficient readers from those at risk of reading difficulties (Murnane et al., 2012). This relationship extends to other core language skills, such as writing, which requires recognizing words, understanding their meanings, forms, and syntactic functions, and using them effectively in context (Maden, 2021). Given its central role in language development, vocabulary instruction is essential for both academic achievement and social growth. In addition to improving literacy skills, vocabulary knowledge also affects social and emotional interactions, because the ability to express thoughts correctly creates a positive impression in daily communication (Bishop et al., 2009).

Address of Corresponding Author

Nurbanu Kansizoğlu, Trabzon University, Fatih Faculty of Education, Department of Turkish and Social Sciences Education, 61335, Trabzon, Türkiye.

✉ nurbanukansizoglu@trabzon.edu.tr

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Vocabulary development strengthens cognitive skills such as thinking and reasoning (Demir, 2006; Karatay, 2007; Özbay & Melanlıoğlu, 2008). As cognitive skills such as comprehension, learning, and critical thinking advance, vocabulary emerges as a key predictor of academic success (Baker et al., 1998; Bishop et al., 2009; Karadağ, 2019). This influence spans multiple academic disciplines. Dunlap and McKnight (1978) found that vocabulary was one of the primary factors influencing students' success in solving mathematical word problems. Similarly, Yalçın and Özek (2006) highlighted the significant connection between vocabulary breadth across various subjects and academic performance, especially in reading comprehension. A rich vocabulary in a specific academic field allows students to understand and express the concepts and principles unique to that area. Therefore, academic success is closely linked to the depth of students' academic language (Bishop et al., 2009). A broad vocabulary enables students to make connections between specialised terms and broader concepts, facilitating deeper understanding and better academic results.

1.2. Effective Vocabulary Teaching Interventions and Current Problems

Language teachers need to introduce students to various vocabulary learning strategies to facilitate vocabulary enhancement (Akyol & Temur, 2013; Allen, 1999; Aydın & Gülden, 2021; Baker et al., 1998; Blachowicz et al., 2006; Bishop et al., 2009; Blachowicz & Fisher, 2000; Karadağ, 2019). Instruction often focuses on direct teaching of word meanings, demonstrating how words are used in different contexts, and encouraging students to actively explore the relationships between words (Blachowicz & Fisher, 2000). This approach provides students with more opportunities to learn new vocabulary and apply strategies when reading and listening, thus supporting the lifelong process of incidental vocabulary acquisition. It also supports learner autonomy by encouraging independent vocabulary learning (Blachowicz & Ogle, 2008). Despite the effectiveness of these strategies, traditional teaching methods—such as using a dictionary to learn word definitions, writing sentences, and relying on teacher explanations—are still prevalent in primary and secondary schools in Türkiye. Research (Göçer, 2016; Göçer & Kılıç, 2020; Karadüz & Yıldırım, 2011; Kontaş, 2023; Uçar, 2012; Uğur, 2014; Yağcı et al., 2012) reveals that teachers do not frequently use different techniques and strategies in vocabulary teaching. While traditional methods can be effective for some students in acquiring vocabulary, they may not suitable for all students. Schmitt (2008) notes that more active, intentional vocabulary learning can lead to "faster gains" (p. 341). However, such methods have been critiqued for limiting students' ability to connect new words to existing knowledge and use them creatively (Bromley, 2007; Halici-Page & Mede, 2018; Kansızoğlu & Bekiroğlu, 2023; Nagy & Scott, 2000). Therefore, instead of rejecting traditional methods as ineffective, it is suggested that adapting vocabulary teaching to the individual needs and learning styles of students may be a more effective strategy.

The development of an age-appropriate vocabulary is seen as essential for developing students' language proficiency at an early age. The study by Biemiller and Slonim (2001) is a pioneering study as it focuses on what should be the common vocabulary of young native speakers of English. Subsequent studies (Alexiou & Vagenas, 2023; Brysbaert, 2016; Coxhead et al., 2015; Green, 2021) have emphasized the importance of deliberate efforts to identify age-appropriate vocabulary in the native language. In the case of Türkiye, the lack of such deliberate efforts has been highlighted (Kansızoğlu & Bekiroğlu, 2023), and recent research (Aykaç, 2017; Dağ, 2017; Eroğlu, 2019; Handemir, 2021; Özcan, 2020; Özen, 2020; Yusufoğlu, 2017) have revealed that Turkish primary and secondary school students have an insufficient active vocabulary in written and oral expressions. These findings indicate that vocabulary teaching, despite its crucial role in various fields and its developmental impact on language skills, remains undervalued. This issue is reflected in the results of the Program for International Student Assessment [PISA], conducted by the Organization for Economic Cooperation and Development [OECD], which Türkiye has participated in since 2003. In the 2019 report, which focused on reading skills, Türkiye ranked 40th out of 79 participating countries and 31st out of 37 OECD countries, scoring below the OECD average in reading skills. Furthermore, Türkiye was one of the 10 countries with the largest gap in reading skills between schools (Ministry of National Education [MoNE], 2019). Given the strong correlation between reading and vocabulary, this is a concerning issue. Additionally, the findings from the project titled "Determining and Measuring Turkish Language Proficiencies in Four Skills", conducted by MoNE in 2020 as part of the 2023 Education Vision, further highlight concerns regarding reading and writing skills. The project, which aimed to assess the basic skills of 1,850 seventh-grade students in 15 provinces, found that the average score on the reading subtest was 10.63 out of 20 points, while performance on the writing subtest was slightly lower (MoNE, 2020). These results suggest that vocabulary instruction in Turkish remains a problematic area, requiring a reassessment of current teaching practices. Several studies in the literature have identified issues with vocabulary instruction in Turkish classrooms. For example, Uçar (2012) found that many teachers were unfamiliar with 23 out of 41 vocabulary teaching methods and techniques. Similarly, Karadüz and Yıldırım (2011) reported that teachers often provide vocabulary instruction in an unplanned and unconscious manner, typically relying on traditional methods. These issues bring into question the effectiveness of current vocabulary teaching interventions in improving cognitive outcomes at the primary and secondary school levels in Türkiye. While meta-analyses on this topic are gaining attention globally, limited research in Türkiye highlights the need for the present meta-analysis.

1.3. Previous Meta-analyses

Numerous have examined vocabulary teaching interventions in second or foreign languages (e.g. studies (Abraham, 2008; Anguiano, 2020; Chen et al., 2018; Chiu, 2013; Elleman et al., 2009; Flack et al., 2018; Mahdi, 2018; Marulis & Neuman, 2010; Stahl & Fairbanks, 1986; Won, 2008). One of the earliest and influential studies on this topic is the meta-analysis by Stahl and Fairbanks (1986), which reviewed 52 experimental studies published prior to 1985. Their findings demonstrated a large effect (d = .97) of vocabulary instruction on the comprehension of texts containing target words. The study also highlighted that methods relying solely on definitional information were not consistently effective in improving comprehension, emphasizing the importance of teaching vocabulary in context. Similarly, Won (2008) conducted a meta-analysis of 43 studies from 1985 to 2006, finding that contextual vocabulary teaching was the most effective method. Elleman et al. (2009), in their analysis of 37 experimental and quasi-experimental studies on vocabulary interventions published between 1950 and 2006, found that vocabulary instruction interventions had a moderate effect on improving students' text comprehension skills.

Marulis and Neuman (2010) examined the effect of vocabulary interventions on children's oral language development through a meta-analysis of 67 experimental and quasi-experimental studies published between 1968 and 2008. The findings demonstrated that vocabulary interventions significantly impacted both receptive and expressive language. It was also found that middle and upper-income students benefited more from vocabulary interventions than low-income students and that small group activities were particularly effective in promoting oral language development. Additionally, other meta-analyses have examined the effectiveness of interventions supported by computer (Abraham, 2008; Chiu, 2013), mobile technology (Lin & Lin, 2019; Mahdi, 2018), shared and multimedia storybooks (Anguiano, 2020; Flack et al., 2018), and digital games (Chen et al., 2018) on vocabulary learning.

In Türkiye, two studies (Haidari et al., 2020; Kansızoğlu, 2017) have focused on vocabulary teaching interventions. Kansızoğlu (2017) analyzed 31 experimental and quasi-experimental studies published between 2000 and 2016 to determine the overall effect of vocabulary teaching interventions on vocabulary development. The results showed that vocabulary teaching methods had a large effect size compared to traditional methods. Haidari et al. (2020) reviewed 34 studies that examined the effects of digital technology-based interventions on vocabulary learning. They concluded that digital technology-based instruction had a positive and significant effect on foreign language vocabulary learning. This study differs from previous research in that it focuses on vocabulary instruction in the mother tongue, specifically analyzing graduate theses conducted at the primary and secondary school levels between 2000 and 2021. In this meta-analysis, Kansızoğlu (2017) concentrated on moderator variables such as publication type, teaching level, implementation period, sample size, and study area, which differs from the focus of the present study. Similarly, Haidari et al. (2020) identified moderator variables including study type, study quality, instructional level, type of technology used, and implementation period. Consequently, the present study differs from other research in terms of the moderator and meta-regression variables.

This study predicts that moderator variables such as retention tests, word identification methods, pilot studies, dependent variables (vocabulary type), and the number of words taught may play a crucial role in determining the effectiveness of vocabulary instruction interventions. Similar to this research, previous meta-analyses on vocabulary knowledge (Flack et al., 2018; Yousefi & Biria, 2018; Zhang et al., 2021) have identified vocabulary type as a moderator variable. It is hypothesized that this factor, considered as the dependent variable, may lead to differences in learning outcomes. This is particularly relevant for idioms and proverbs, which often carry figurative meanings and are generally more challenging to learn than words with direct meanings.

Additionally, Webb et al. (2023) identified methodological features and text type as moderator variables, demonstrating that these factors influence the extent of incidental vocabulary learning. Flack et al. (2018) also selected the number of vocabulary items taught as a moderator variable, as it may reflect differences in students' cognitive abilities and learning processes. Several meta-analyses on vocabulary instruction (Kansızoğlu, 2017; Marulis & Neuman, 2010; Yun, 2011) have explored how effect sizes vary based on sample size. Marulis and Neuman (2010) found that small group activities were particularly effective in enhancing oral language skills, while Yun (2011) observed that studies with larger sample sizes reported higher effect sizes. In contrast, Kansızoğlu (2017) concluded that sample size did not significantly influence effect size values.

In this study, sample size and vocabulary type were selected as meta-regression variables to provide a more comprehensive understanding of the effect sizes of vocabulary instruction interventions by considering multiple influencing factors.

1.3.1. The Aim and Research Questions

The aim of this study is to assess the overall impact of vocabulary development interventions on vocabulary-related cognitive outcomes. To achieve this aim, the following research questions will be examined:

RQ 1) Do the effects of vocabulary interventions on cognitive outcomes differ significantly based on specific study characteristics (e.g., pilot study, retention test, methods for determining vocabulary, dependent variable, and the number of vocabulary items taught)?

RQ 2) What is the extent of the individual and cumulative effects of sample size and the number of vocabulary items taught on effect sizes?

2. Method

This study is designed according to the meta-analysis method to evaluate quasi-experimental and experimental vocabulary teaching interventions. Meta-analysis, characterized as an "analysis of analyses" by Glass (1976), aims to enhance the precision of predictions by providing a general average of the effect size values derived from individual studies (Şen & Yıldırım, 2020). In this meta-analysis, effect sizes were calculated, heterogeneity was assessed, publication bias analyses were conducted, and subgroup analyses (Analog ANOVA) and meta-regression analyses were performed by following the steps outlined in the following sections.

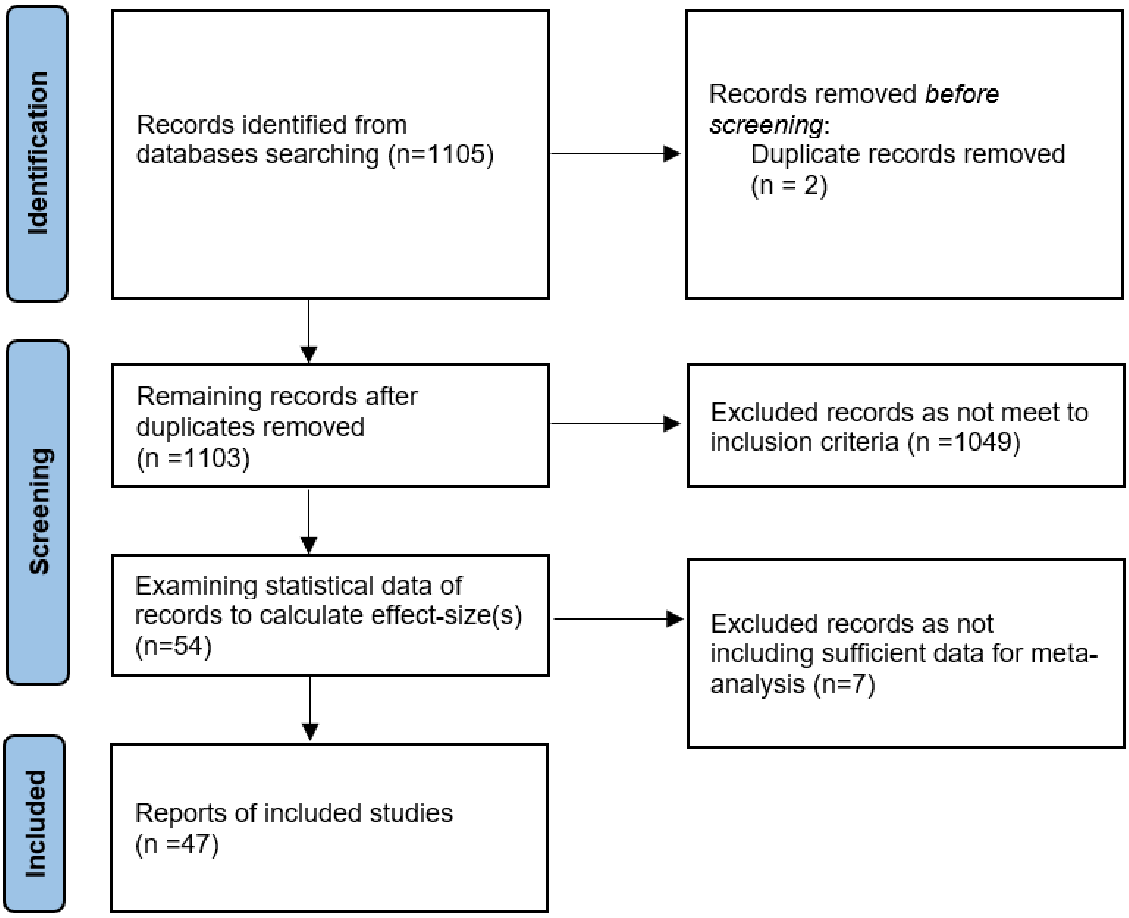
2.1. Application Flow

2.1.1. Search strategy

For this study, master's and doctoral theses were obtained from the Turkish Higher Education Institution National Thesis Center's online database. This platform offers researchers in Türkiye access to detailed information, including subject, university, institute, department, index, abstract, and full text, allowing for comprehensive searches. Since it is mandatory for all graduate studies conducted at universities in Türkiye to be archived in this database, it serves as a reliable source for academic research. This study specifically focused on dissertations to gain a deeper understanding of vocabulary instruction interventions and their effects. Compared to journal articles, which often provide limited details, theses offer more comprehensive information on intervention methods and research designs, making them better suited for the study's objectives.

Various keywords were used in the search conducted in September 2020[2]. The reason for choosing these keywords is that words, proverbs, idioms, phrases, formulaic words, and terms are shown among the elements that form the vocabulary in literature (Aksan, 2015). In the initial search, which did not apply any exclusion criteria, a total of 1,105 theses were identified. The flowchart illustrating the search process is presented in Figure 1.

Figure 1
PRISMA chart of the screening process



[2]Because the search in the thesis bank was conducted in Turkish, the following keywords were used: kelime öğretimi, sözcük öğretimi, kelime hazine, kelime hazne, kelime dağarcığı, kelime bilgisi, zihinsel sözlük, kelime servet, kelime kadro, söz varlığı, deyim, atasöz, ikileme, kalıp söz, kalıplaşmış söz, ilişki söz, özdeyiş, yabancı kökenli sözcük, yabancı kökenli kelime, yabancı kelime, yabancı sözcük.

2.1.2. Eligibility criteria

The inclusion criteria for this study were as follows: (i) the intervention had to focus on vocabulary teaching; (ii) the study needed to provide the necessary statistical data (mean, standard deviation, sample size) for meta-analysis calculations; (iii) the interventions had to be conducted within the context of Turkish language instruction; (iv) the activities had to take place at the primary and secondary school levels (2nd to 8th grades); (v) the study had to be published between 2000 and 2021; and (vi) the study had to employ an experimental or quasi-experimental design. The exclusion criteria were: (i) studies conducted in the field of teaching Turkish as a foreign language and (ii) studies with limited accessibility. As a result, 47 studies that met both the inclusion and exclusion criteria were selected for analysis.

However, not all 47 studies included in the analysis were ultimately part of the meta-analysis. In Table 1, the lower limit of the 95% confidence interval for four studies exceeds the upper limit of the confidence interval for the mean effect size, which is 1.596. When the parameters and values used to assess potential publication bias were examined, it was found that Bitir's (2017) study contributed to publication bias and led to its classification as an outlier based on the effect size obtained. In addition, although the standardised residuals of the studies by Gülsoy (2013), Süner (2021) and Şahin (2018) do not exceed 3, they are close to this value and require further evaluation.

Table 1
Weights and Residuals for Potential Outlier Studies

Weight (random effects model)			*Residual value (random)*		
Study	*Raw weight*	*Relative weight*	*Standard error*	*Standardized residual value (random effects model)*	*p*
Bitir (2017)	1.26	1.62	0.88	3.59	<.01
Gülsoy (2013)	1.47	1.89	0.82	2.7	.01
Süner (2021)	1.36	1.75	0.85	2.83	<.01
Şahin (2018)	0.97	1.25	1.01	2.3	.02

As a result of the outlier analysis, outlier studies (Bitir, 2017; Gulsoy, 2013; Süner, 2021; Şahin, 2018) were identified and analyses were conducted with 43 studies. Appendix 1 presents the descriptive data of the 43 studies included in the meta-analysis.

2.2. Coding Reliability

Coding improves dataset readability by structuring raw study data in an organized manner (Ellis, 2010). To ensure coding reliability, 15 studies were randomly selected from the 47 included in the meta-analysis. Two field experts independently coded key study information (e.g., sample size, pilot study, retention test) into a data table. The inter-coder reliability was assessed using the Cohen's Kappa coefficient, which yielded a value of 0.89, indicating a high level of agreement. Following the coding process, the researchers compared their data and resolved any discrepancies through discussion and revision.

2.3. Calculation of Effect Sizes and Data Analysis

Calculations and analyses pertaining to effect sizes were conducted using the Comprehensive Meta-Analysis V3 [CMA] software. This meta-analysis employed the Hedge's g index for effect size calculations. Hedge's g is designed to minimize the bias inherent in Cohen's d, an index derived from dividing the mean difference obtained from individual studies by the standard deviation value, using a correction formula (Borenstein et al., 2009). It is recommended that in a meta-analysis, the Hedge's g index be used to achieve a general standard, particularly when studies include both samples of fewer than 20 participants and those with more than 20 participants (Şen & Yıldırım, 2020). Consequently, the effect sizes for all studies included in the meta-analysis were calculated using the Hedge's g index.

For each study, the average Hedge's g, along with the lower and upper limits of effect sizes at 95% confidence intervals, standard error, Z-values, and *p*-values were computed. When a study encompassed both an experimental group and a control group with available pre- and post-test data, both sets of data were entered into the software to provide a more precise estimation of the intervention's effect. In these situations, given that specific values were not reported in any of the studies included in the meta-analysis correlation values of r = .3, .6, and .9 were entered for the pre- and post-intervention measurements, as suggested in the relevant literature (Şen & Yıldırım, 2020). It was observed that these correlation values did not significantly affect the effect size values; therefore, a correlation value of 0.6 was ultimately chosen as the pre-test and post-test correlation value for the final analysis. Furthermore, considering the relevant literature (Borris, 1997, as cited in Şen & Yıldırım, 2020), standardization was performed on the post-test data due to the inclusion of both pre-test control group and post-test control group studies. Additionally, it has been emphasized that results obtained from the same sample are considered dependent and should not be evaluated as independent (Cooper et al., 2019), studies that produced more than one effect size were incorporated into the final analysis as a single average effect size. The effect size for these studies reflects the average of the effect sizes of the various variables examined.

2.4. Heterogeneity Test

Heterogeneity refers to the extent of variability among effect sizes within a study. Various methods can be employed to assess this variability, including the calculation of the Q statistic and the I^2 value (Şen & Yıldırım, 2020). A significant Q value indicates that the effect sizes across the studies reveal heterogeneity. Conversely, a non-significant Q value suggests that the effect sizes are homogeneous, implying that the variation necessary for conducting moderator analyses is inadequate (Borenstein et al., 2009). Furthermore, if the Q value exceeds the critical threshold indicated for the corresponding degrees of freedom at the predetermined significance level in the chi-square (χ^2) table, this indicates heterogeneity among the individual studies included in the meta-analysis. The I^2 statistic quantifies the percentage of variability in effect estimates attributable to heterogeneity rather than to sampling error. Specifically, an I^2 value of 0%-40% is considered non-significant, 30%-60% moderate, 50%-90% significant, and 75%-100% reflects very significant heterogeneity (Deeks et al., 2019). In this study, a forest plot, Q statistic, I^2, and associated significance values were employed to interpret the overall effect and facilitate moderator analyses.

2.5. Outlier Analysis

When the distribution of effect sizes reveals extreme values that significantly differ from most other effects, these extreme effects can have a disproportionate influence on the statistics calculated in the analysis (Lipsey & Wilson, 2001). Accordingly, an outlier analysis was conducted. This analysis involved examining the standardized residual values for each study included in the meta-analysis. Studies with an absolute value greater than 3 were considered potential outliers (Şen & Yıldırım, 2020, p. 68). Studies were classified as outliers if the upper limit of the 95% confidence interval was lower than the lower limit of the confidence interval for the average effect size, or if the lower limit of the 95% confidence interval was higher than the upper limit of the confidence interval for the average effect size. Studies identified as outliers are those determined to not reflect the population included in the meta-analysis and are therefore classified as outliers. Consequently, the conditions excluding outliers were reported in both overall effect size calculations and subgroup and meta-regression analyses.

2.6. Validity and Reliability of the Research

To ensure the reliability of the meta-analysis study, every stage of the research was clearly reported, and a thorough literature review was conducted. In this context, all stages of the process of accessing primary studies are shown in a flowchart. Publication bias is the most significant problem that limits the reliability of meta-analytic studies (Card, 2012). To assess the bias of the studies included in this meta-analysis and their resistance to publication bias, Orwin's Fail-Safe N

Method, Rosenthal's Fail-Safe N Method, and a Funnel Plot were utilized. Additionally, to ensure reliability, two experts performed coding, and the Cohen Kappa statistic was used to evaluate the agreement between coders. In this regard, approximately 40% of the studies (18 studies) were randomly selected and coded and categorized by the experts. The Cohen Kappa value, indicating the reliability between the coders, was calculated as 0.91. The issues where consensus was not reached were taken into consideration.

3. Findings

3.1. Findings on Publication Bias

Publication bias, fundamentally an issue related to the conduct, dissemination, and interpretation of individual studies (Sutton, 2009). It is related to publications that do not systematically represent the population of completed studies (Rothstein et al., 2005). The overall effect of vocabulary development interventions on the cognitive outcomes of vocabulary was determined through an analysis involving 43 studies (excluding outliers). Prior to this analysis, publication bias in the studies was analyzed. In this context, the results of Rosenthal's Fail-Safe N Test examined are presented in Table 3.

Table 3
Rosenthal's Fail-Safe N Test Indicating Bias Status

Bias status	*Value*
Z-value for Studies Reviewed	30.884
p-value for Studies Reviewed	.00
Alpha	.05
Z-value for Alpha	1.959
Number of studies reviewed	43
Fail-safe Number [FSN]	635

According to the results of Rosenthal's Fail-Safe N test presented in Table 3, it is necessary to have 635 studies with an effect size of zero for the statistical significance value of $p = 0.00$ to be nullified. When applying the formula N/(5k+10) developed by Üstün and Eryılmaz (2014), which cites Mullen et al. (2001), the extent to which this study is resistant to future research can be understood. The calculation yields a value of 2.82, derived from 635/(5×43+10), which exceeds the critical value of 1. This indicates that the results of this meta-analysis, investigating the effects of vocabulary development interventions on students' vocabulary-related cognitive outcomes, are resistant to the findings obtained in individual studies. Additionally, Orwin's Fail-Safe N method, another test for publication bias, shows similar results. The results of this test are presented in Table 4.

Table 4
Orwin's Fail-Safe N Test Indicating Publication Bias

Bias status	*Value*
Hedge's g for observed studies	0.9638
Benchmark for "Junk" Hedge g	0.1
Hedge g averaged for missing studies	0.00
FSN	372

An analysis of the values in Table 3 reveals that a total of 372 studies would be needed for the effect size to decrease to the insignificant threshold of 0.1, as indicated by the Hedge's g value. While these findings suggest that the research results are resistant to publication bias, a different outcome emerges in the initial analysis involving 47 studies (including outliers) with the Begg and Mazumdar test and Egger's regression test. The results of the Begg and Mazumdar rank correlation test conducted with 43 studies indicate a Kendall's Tau value of 0.403, a one-tailed *p*-value of .00007, and a two-tailed *p*-value of .00014, suggesting the potential for publication bias in the meta-analysis. Findings from Egger's test (β_0 = 2.90579; 95% CI = [0.94224, 4.86935]; t = 2.98864, p (1-tailed) = .00236; p (2-tailed) = .00472) also indicate the possibility of publication bias in the studies. Furthermore, these values are more favorable compared to the initial analysis that included outliers. The funnel plot reveals that the asymmetry, which was distinctly observed in the first analysis, has somewhat improved. This funnel plot is presented in Figure 1.

Figure 1
Funnel Plot of Standard Error Based on Hedge's g

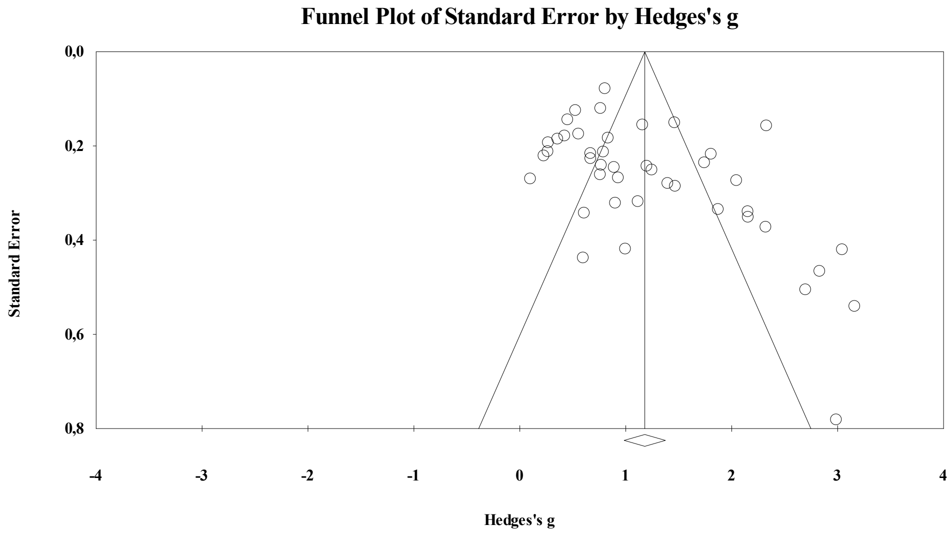


Figure 1 illustrates the distribution of standard errors and Hedge's g effect sizes for the 43 studies included in the meta-analysis. When compared to the initial analysis, it is evident that the number of studies located to the right of the mean, which contributed to the asymmetry, has decreased. This situation is also reflected in the funnel plot of precision obtained by taking the inverse of the standard error, as shown in Figure 2.

Figure 2
Funnel Plot of Precision Based on Hedge's g

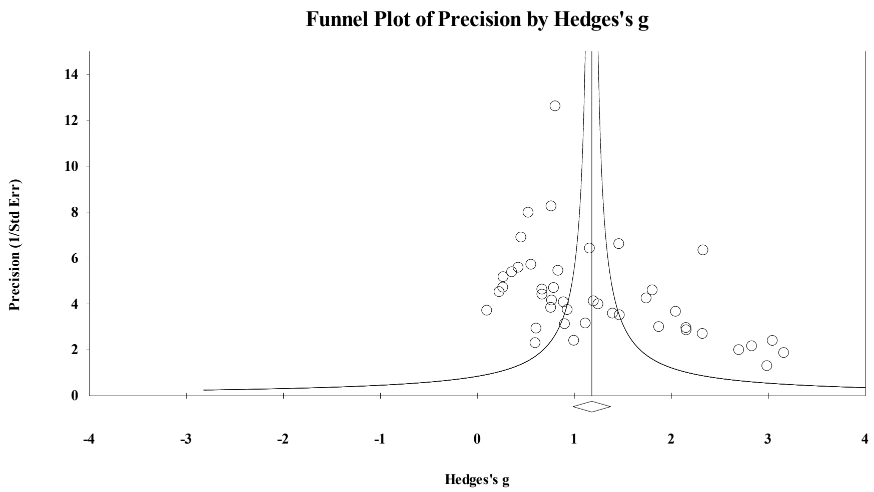


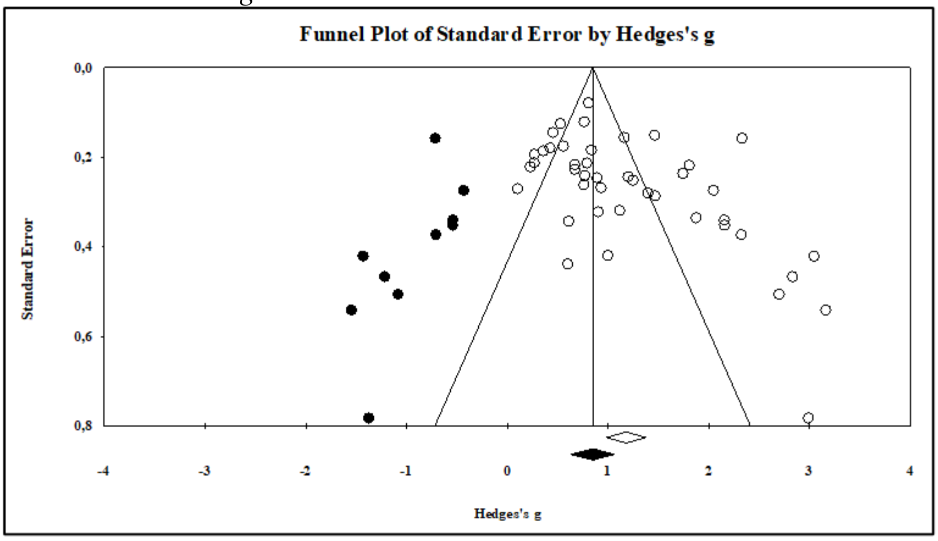
Figure 2 shows that the asymmetry is less noticeable compared to the previous analysis. To statistically demonstrate this improvement concerning publication bias and to calculate a corrected effect size, Duval & Tweedie's "trim and fill" method has been reapplied. The results of the analysis conducted using this method are presented in Table 5.

Table 5
Average Effect Size Calculated Using Duval and Tweedie's Trim and Fill Method

		Fixed effects model		Random effects model		Q
	Clipped work	ES	95% CI	ES	95% CI [Lower limit; upper limit]	
Observed values	-	0.963	[0.901; 1.026]	1.179	[0.985; 1.374]	364.218
Adjusted values	10	0.811	[0.751; 0.87]	0.848	[0.629; 1.067]	634.873

Table 5 shows that the number of studies that need to be added to the left of the average to correct for bias is 10. In the previous analysis, which included outliers, this number was determined to be 12. Based on these findings, it can be concluded that the dispersion of the 43 studies is more symmetrical. As a result, the adjusted effect size is g = 0.848 [%95 CI = [0.629, 1.067]], and the Q value is 634.087. Figure 3 presents the funnel plot showing the studies necessary for correcting the bias.

Figure 3
Funnel Plot Showing the Filled Studies



As seen in Figure 3, when 10 studies are added to the left side of the graph, the asymmetry is eliminated. The precision graph also exhibits a similar pattern.

3.2. Findings on the Overall Effect of Vocabulary Development Interventions on the Cognitive Outcomes of Vocabulary

When evaluating the findings under the random effects model presented in Table 6, it is observed that the average effect of interventions aimed at improving vocabulary on vocabulary outcomes is substantial (g = 1.179, 95% CI [0.985, 1.374], $p < .05$). In other words, interventions designed to enhance vocabulary have a statistically significant and positively greater effect on students' vocabulary development compared to traditional word teaching methods. The common feature of these interventions is that they are innovative and student-centered. In contrast, traditional methods include teacher-centered and context-free practices such as listing and looking up word meanings in a dictionary. The findings of the basic values (Hedges g, standard error and p) of the studies included in the meta-analysis are shown in Table 7.

Table 6
The Effect of Interventions Aimed at Developing Vocabulary on the Cognitive Outcomes of Vocabulary

Model	*k*	*ES*	*SE*	*95% CI [Lower limit; upper limit]*	*Z*	*p*
Fixed	43	0.964	0.032	[0.902; 1.026]	30.32	.00
Random	43	1.179	0.099	[0.985; 1.374]	11.888	.00

Note. k= number of studies; ES: Effect size; SE: Standard error; CI: Confidence interval.

Table 7
The Findings of the Basic Values of the Studies Included in the Meta-Analysis

Study Name	*Hedges' g*	*Standard Error*	*p*
Akın (2018)	1.811	0.219	.000
Akyıldız (2019)	2.334	0.158	.000
Aydoğdu (2019)	1.466	0.152	.000
Balaban (2019)	0.768	0.121	.000
Bilgin (2018)	0.105	0.271	.698
Bulut (2013)	0.428	0.180	.017
Cingöz (2017)	3.166	0.542	.000
Çelik (2004)	1.164	0.156	.000
Çelikkol (2007)	0.673	0.217	.002
Çetinkaya (2002)	0.362	0.186	.052
Demirel-İşbulan (2010)	0.839	0.184	.000
Durmaz (2020)	2.327	0.374	.000
Er (2013)	1.878	0.336	.000
Genç-Ersoy (2017)	0.613	0.344	.075
Gül (2009)	1.401	0.281	.000
Gülcan (2010)	2.051	0.274	.000
Güney-Mürsel (2009)	0.764	0.262	.004
İlhan (2016)	0.934	0.269	.001
Kara (2018)	3.049	0.421	.000
Kazıcı (2008)	0.273	0.194	.160
Koçpınar (2018)	0.895	0.247	.000
Kodan (2011)	0.560	0.176	.001
Kurt (2018)	1.748	0.237	.000
Okur (2007)	1.204	0.244	.000
Oruç (2011)	2.993	0.782	.000
Örge (2003)	2.158	0.341	.000
Özaslan (2006)	1.002	0.420	.017
Özer (2007)	0.674	0.228	.003
Sevim (2019)	0.270	0.213	.205
Soylu (2020)	1.472	0.287	.000
Şahin (2019)	2.703	0.506	.000
Şenol (2011)	0.907	0.322	.005
Tağa (2018)	0.457	0.145	.002
Tanrıverdi (2019)	0.603	0.439	.169
Taşdemir-Bulut (2006)	2.160	0.352	.000
Taşkın (2019)	1.121	0.319	.000
Tek (2021)	0.231	0.222	.298
Tuğyan (2010)	0.809	0.079	.000
Ulu (2019)	0.773	0.242	.001
Uysal (2020)	1.252	0.252	.000
Varan (2017)	2.836	0.467	.000
Yeğen (2020)	0.531	0.126	.000
Yıldırım (2010)	0.793	0.214	.000
Random	1.179	0.099	.000

Table 7 illustrates that all effect sizes are positively oriented, indicating an advantage for the experimental group and/or post-test, with effect sizes ranging from g = 0.105 to g = 3.166. This variation is not statistically significant in seven studies (Bilgin, 2018; Çetinkaya, 2002; Genç Ersoy, 2017; Kazıcı, 2008; Sevim, 2019; Tanrıverdi, 2019; Tek, 2021). See Appendix 2 for the forest plots, which provide a visual summary of the effect sizes collected in this study.

3.3. Findings Related to Moderator Analyses

Subgroup (Analog ANOVA) analyses were conducted for categorical variables such as pilot study, retention test, method of determining words, vocabulary outcome, and the number of vocabulary items taught.

3.3.1. Findings related to the categorical variable of the pilot study

Table 8 summarizes the variation in effect size values based on the presence of a pilot study, analyzing its influence on the effects of vocabulary improvement interventions.

Table 8
Subgroup Analysis According to the Moderator of Conducting a Pilot Study

Pilot study	*k*	*g*	*SE*	σ^2	*95% CI [Lower limit; upper limit]*	*p*	Q_b *(p)*
Yes	6	0.970	0.244	0.06	[0.491; 1.449]	.00	0.859 (*df*=1)
No	37	1.22	0.114	0.013	[0.996; 1.444]	.00	*p* = .354
Overall	43	1.175	0.104	0.011	[0.972; 1.378]	.00	

Note. Studies with outliers (Bitir, 2017; Gulsoy, 2013; Süner, 2021; Şahin, 2018).

As seen in Table 8, the results of the subgroup analysis conducted with 43 studies revealed no statistically significant difference between the overall effect size obtained from the 6 studies that conducted a pilot study (g = 0.97) and the effect size obtained from the 37 studies that did not conduct a pilot study (g = 1.22) (p = .354). The calculated Q value is below the critical value of 3.841 determined for 1 degree of freedom at the 95% significance level in the χ^2 table (Q_B = 0.859). Although the effect size of the studies without a pilot study is higher than that of the studies that conducted one, this difference is not statistically significant. In summary, the “pilot study” moderator does not have the power to differentiate the effect of interventions aimed at improving vocabulary.

3.3.2. Findings related to the categorical variable of the retention test

Table 9 presents data summarizing the variation in effect size values based on whether a retention test was conducted, examining its impact on the effects of vocabulary improvement interventions.

Table 9
Subgroup Analysis According to the Moderator of Conducting a Retention Test

Retention test	*k*	*g*	*SE*	σ^2	*95% CI [Lower limit; upper limit]*	*p*	Q_b *(p)*
Yes	8	1.397	0.272	0.074	[0.864; 1.93]	.00	0.756 (*df*=1),
No	35	1.14	0.114	0.013	[0.916; 1.364]	.00	*p* = .384
Overall	43	1.179	0.105	0.011	[0.972; 1.385]	.00	

Note. Studies with outliers (Bitir, 2017; Gulsoy, 2013; Süner, 2021; Sahin, 2018).

As seen in Table 9, many studies investigating the effects of interventions designed to improve vocabulary did not conduct a retention test after the post-test. The difference between the effect size obtained from the 8 studies that conducted a retention test (g = 1.397) and the effect size from the 35 studies that did not conduct this test (g = 1.14) is not statistically significant (p = .384 > .05). The between-group heterogeneity value (Q_B = 0.756) does not exceed the critical value of 3.841, calculated for 1 degree of freedom in the χ^2 table. This indicates that the effect of interventions aimed at improving vocabulary does not significantly differ depending on whether a retention test was conducted.

3.3.3. Findings related to the categorical variable of the method for determining words

Table 10 presents the results of the moderator analysis conducted to examine whether the effects of interventions aimed at improving vocabulary significantly differ based on how the words to be taught were determined in individual studies.

Table 10

Subgroup Analysis According to the Moderator of the Method for Determining Words

Identifying words	*k*	*g*	*SE*	σ^2	*95% CI [Lower limit; upper limit]*	*p*	Q_b *(p)*
Textbook	21	1.123	0.143	0.02	[0.843; 1.403]	.00	0.269 (*df*=1),
Literary book/text	11	1.269	0.242	0.059	[0.794; 1.744]	.00	*p* = .604
Overall	32	1.161	0.123	0.015	[0.920; 1.402]	.00	

Note. Studies containing outliers (Bitir, 2017; Gülsoy, 2013; Süner, 2021; Şahin, 2018); studies that were not included in the analysis because the number of frequencies in the category they were in fell below 4 (Akyıldız, 2019; Aydoğdu, 2019; Bulut, 2018; Çelik, 2004; Çelikkol, 2007; Güney-Mürsel, 2009; Örge, 2003; Özaslan, 2006; Tuğyan, 2010); studies in which the way the words were determined was not reported (Er, 2013; İlhan, 2016).

As shown in Table 10, the moderator variable related to the method of determining words—reflecting the diversity of sources from which the taught words were selected—does not significantly influence the effect size values. Accordingly, the overall effect size from the 11 studies where the words were taken from literary books or texts (g = 1.269) is similar to the effect size from the 21 studies where the words were taken from textbooks (g = 1.123). The between-group heterogeneity value (Q_b = 0.269) is well below the critical value of 3.841 calculated for 1 degree of freedom in the χ^2 table, and the non-significant *p*-value (*p* = .604) indicates that the distribution of effect sizes is homogeneous. Therefore, the effect of interventions aimed at improving vocabulary does not significantly differ depending on the method used to determine the taught words in individual studies. This can be interpreted to mean that selecting words from textbooks or literary books produces similar effects.

3.3.4. Findings related to the categorical variable of vocabulary output (dependent variable)

Table 11 presents the results of the analysis examining whether the effects of interventions aimed at improving vocabulary differ significantly depending on the vocabulary output (dependent variable).

Table 11

Subgroup Analysis According to the Moderator of Vocabulary Output (Dependent Variable)

Vocabulary output	*k*	*g*	*SE*	σ^2	*95% CI [Lower limit; upper limit]*	*p*	Q_b *(p)*
Idiom knowledge	7	1.424	0.308	0.095	[0.821; 2.027]	.00	2.396 (*df*=2),
Mixed	16	1.013	0.133	0.018	[0.753; 1.273]	.00	*p* = .302
Vocabulary knowledge	12	1.321	0.226	0.051	[0.877; 1.765]	.00	
Overall	35	1.132	0.107	0.012	[0.922; 1.343]		

Note. Studies with outliers (Bitir, 2017; Gülsoy, 2013; Süner, 2021; Şahin, 2018); studies that were not included in the analysis because the number of frequencies in the category they were in fell below 4 (Akyıldız, 2019; Tuğyan, 2010); studies including "combined" situations where there are different effect sizes belonging to more than one dependent variable and these are represented by a single effect size (Balaban, 2019; Durmaz, 2020; Kazıcı, 2008; Kurt, 2018; Özaslan, 2006; Tağa, 2018)

An examination of the data in Table 11 reveals positive effect sizes across all categories. The category with the fewest studies, "idiom knowledge," shows the highest effect size (g = 1.424), whereas the category with the most studies, the mixed category with 16 studies, has the lowest effect size (g = 1.013). However, the effect sizes in all three categories indicate a large effect. In other words, instructional interventions aimed at improving vocabulary have a significant impact on all vocabulary-related outcomes. The between-group heterogeneity test shows that the Q_B value of 2.396 is below the χ^2 critical value of 5.991, calculated for 2 degrees of freedom at the 95% confidence level, indicating that the groups are homogeneous. Moreover, the difference in effect sizes between the groups is not statistically significant (*p* = .302). This suggests that instructional interventions aimed at improving vocabulary have a similar effect on vocabulary outcomes, and the "vocabulary output" moderator does not differentiate the effect size values.

3.3.5. Findings related to the categorical variable of the number of taught vocabulary words

Table 12 presents the results of the analysis examining whether the effects of interventions aimed at improving vocabulary differ significantly based on the number of vocabulary words taught.

Table 12
Subgroup Analysis According to the Moderator of Number of Taught Vocabulary Words

Number of vocabulary taught	*k*	*g*	*SE*	σ^2	*95% CI [Lower limit; upper limit]*	*p*	Q_b *(p)*
10-19	8	1.681	0.353	0.125	[0.989; 2.373]	.00	1.905,
20-29	8	1.552	0.305	0.093	[0.953; 2.15]	.00	(*df*=2),
50-59	4	1.071	0.322	0.440	[0.44; 1.702]	.001	*p* = .386
Overall	20	1.425	0.188	0.035	[1.057; 1.793]		

Note. Studies containing outliers (Bitir, 2017; Gülsoy, 2013; Süner, 2021; Şahin, 2018); studies that were not included in the analysis because the number of frequencies in their category fell below 4 (Aydoğdu, 2019; Balaban, 2019; Çelikkol, 2007; Gül, 2009; Kara, 2018; Tağa, 2018; Tanrıverdi, 2019; Taşkın, 2019; Uysal, 2020; Varan, 2017) studies where the number of vocabulary items was not reported (Bilgin, 2018; Çelik, 2004; Genç Ersoy, 2017; İlhan, 2016; Koçpınar, 2018; Okur, 2007; Özaslan, 2006; Sevim, 2019; Tek, 2021; Tuğyan, 2010; Ulu, 2019; Yegen, 2020; Yıldırım, 2010).

As seen in Table 12, the effect size obtained from studies where 10-19 vocabulary words were taught (g = 1.681) represents the category with the largest effect among all categories. This is followed by the 20-29 category (g = 1.552) and the 50-59 category (g = 1.071). When the values are examined, it is observed that the effect size is greater in studies where fewer vocabulary words were taught. However, the significance test shows that this difference is not statistically significant ($p > .05$). The results of the between-group heterogeneity test also confirm this finding, as the Q_B value of 1.905 does not exceed the χ^2 critical value of 5.991, calculated for 2 degrees of freedom at the 95% confidence level. This suggests that the number of vocabulary words taught does not have a significant effect on differentiating the effect sizes.

3.4. Findings Related to Meta-Regression

The predictive power of the variables sample size and number of taught vocabulary words on changes in effect sizes was tested individually and together. Meta-regression findings regarding the prediction of changes in the dependent variable by sample size and number of words taught were investigated. Table 13 presents the results of the meta-regression analysis based on the method of moment.

In the first model presented in Table 13, the variance among effect sizes is attempted to be explained by sample size. The findings indicate that this model produces significant results (QM (df = 7) = 24.8; $p < .05$). As a result of the analysis, the total variance was calculated as 0.474. When sample size is used as a covariate, the unexplained variance is 0.257. Therefore, the explained variance is calculated as 0.474 − 0.257 = 0.217. According to the formula for explained heterogeneity R^2 = [Explained/Total] x 100, the value is calculated as [0.217/0.474] x 100 = 45.7%. In the second model, the number of vocabulary words taught was tested as a covariate. The analysis revealed that this model does not have a significant predictive effect on the effect size values (QM (df = 1) = 2.37, $p > .05$).

As shown in Table 13, the third model, which attempts to explain the variance among effect sizes by both sample size and the number of vocabulary words taught (QM (df = 8) = 25.7; $p < .05$), produces significant results. According to random effects model, the total variance among studies is 0.4739. When sample size and the number of vocabulary words taught are used as moderators, the unexplained variance is 0.2617. Thus, the explained variance is 0.4739 − 0.2617 = 0.212. According to the formula for explained heterogeneity R^2 = [Explained/Total] x 100, this results in [0.212/0.474] x 100 = 44.7%. This indicates that 44.7% of the variance among studies is explained by the number of vocabulary words taught. Consequently, the unexplained variance is 55.3%.

Table 13

Results of Meta-Regression Analysis According to the Method of Moments

Findings								*Testing the model*				*Goodness of fit*		
Model	k	Variable	β	SE	Two-way p	*p*		*Q*	df	*p*	Tau²	*Q*	df	*p*
Model 1 (Sample size)	27	Fixed	1.631	0.382	0.00		0.46(0.217/0.474)	24.84	7	0.0008	0.256	101.39	19	.00
		20-29	−0.048	0.621	0.938									
		30-39	1.357	0.632	0.032									
		40-49	−0.405	0.461	0.379									
		50-59	0.548	0.465	0.239									
		60-69	−0.604	0.475	0.203									
		70-79	−0.704	0.469	0.134									
		80-89	−0.523	0.5	0.296									
Model 2 (Number of vocabulary taught)	27	Fixed	1.775	0.242	0.0000		0.09 (0.0409/0.474)	2.37	1	0.1235	0.433	219.9	25	.00
		Number of vocabulary taught	−0.0073	0.0047	0.1235									
Model 3 (Sample size + Number of vocabulary taught)	27	Fixed	1.835	0.427	0.000	Q = 22.1 (df = 7) *p* = .0024	0.45 (0.212/0.474)	25.7	8	0.0012	0.262	95.45	18	.00
		Sample size (20-29)	−0.154	0.632	0.808									
		Sample size (30-39)	1.385	0.637	0.029									
		Sample size (40-49)	−0.364	0.466	0.434									
		Sample size (50-59)	0.462	0.476	0.331									
		Sample size (60-69)	−0.661	0.482	0.17									
		Sample size (70-79)	−0.665	0.475	0.161									
		Sample size (80-89)	−0.444	0.509	0.384									
		Number of vocabulary taught	−0.0047	0.0043	0.269									

Note. β = regression coefficient, SE = Standard Error; R^2: Total variance in actual effects explained by the model.

Compared to the first model, it is observed that the predictive power of sample size as a single explanatory variable is slightly higher than that of sample size in conjunction with the number of vocabulary words taught.

4. Discussion and Conclusion

This study aimed to determine the overall impact of various strategies, methods, techniques, and materials used in vocabulary teaching on students' vocabulary development, analyzing 43 theses through meta-analysis. The effect sizes for these 43 studies were calculated to assess the overall effect of vocabulary development interventions on vocabulary-related cognitive outcomes (such as success and skills). The average effect size for interventions aimed at vocabulary development was found to be (g = 1.179, 95% CI [0.985, 1.374], $p < .05$) based on the random effects model. This suggests that interventions focused on improving vocabulary are significantly more effective than traditional methods in enhancing students' vocabulary knowledge. Methods such as creative drama, cooperative learning, educational games, and animations were identified as particularly beneficial for supporting students' vocabulary acquisition. These copnsistent with those of other meta-analytic studies in the field (Elleman et al., 2009; Kansızoğlu, 2017; Marulis & Neuman, 2010; Won, 2008; Yousefi & Biria, 2018), all of which demonstrate the significant impact of vocabulary teaching interventions on vocabulary learning success, vocabulary development, or expressive language growth. A consensus in the literature highlights that teaching only word definitions is insufficient for developing comprehensive vocabulary knowledge (Barchers, 1998; Beck & Bromley, 2007; Diamond & Gutlohn, 2006; Marzano, 2004; McKeown, 2007). For example, Barchers (1998) notes that practices such as memorizing word lists and writing dictionary definitions are widely used but do not result in effective learning outcomes. In these approaches, the teacher often only explains word meanings, neglecting practices like relating new words to previously learned ones, analyzing word structures, and using words in creative, original ways (Bromley, 2007).

The Turkish curriculum clearly emphasises a focus on the functional use of words rather than memorisation and passive learning. Success in vocabulary development is reflected in students' ability to better understand what they hear and read, as well as to produce more competent oral and written outputs (MoNE, 2024). Learning a word is more than just memorizing it; it requires deeper understanding and effective usage. Teachers should encourage students to use newly learned words in diverse contexts across listening, speaking, reading, and writing activities, promoting active engagement with the words.

Moreover, considering different approaches and valuing students' learning styles and classroom organization is crucial (Blachowicz et al., 2006). Therefore, the teaching process should be adapted to address individual differences among students and create learning environments that increase vocabulary depth. Vocabulary learning is a lifelong process that supports personal and professional growth. Thus, one of the goals of vocabulary teaching is to equip students with strategies they can apply throughout their lives. Various researchers (e.g. Blachowicz et al., 2006; Blachowicz & Ogle, 2008; Blachowicz & Fisher, 2000; Bromley, 2007) emphasise the importance of supporting students to develop independent vocabulary learning strategies. The Turkish language curriculum, centered on teaching strategies and methods, encourages students to acquire skills they can use independently, described as the ability to "successfully complete challenging tasks and achieve their goals" (MoNE, 2024). This study highlights the significance of the strategies, methods, and techniques in fostering students' independence in vocabulary learning.

In this study, subgroup analysis of five moderators (pilot study, retention tests, word selection method, vocabulary knowledge outcome [dependent variable], and the number of words taught) revealed that none had a significant effect on explaining the heterogeneity in effect sizes. In other words, these moderator variables did not significantly explain the differences observed in the effect sizes of the studies analyzed. Meta-analyses on vocabulary knowledge have identified vocabulary knowledge type (Flack et al., 2018; Kansızoğlu, 2017; Yousefi & Biria, 2018), methodological characteristics, text type (Webb et al., 2023), the number of words taught (Flack et al., 2018), and sample size (Kansızoğlu, 2017; Marulis & Neuman, 2010; Yun, 2011) as moderator variables. Flack et al. (2018) found that verbs are easier to learn than nouns but do not have a strong effect on vocabulary learning. Yousefi and Biria (2018) identified that abstract words have a larger effect size for adults compared to concrete words; however, the difference was not statistically significant. Similarly, Kansızoğlu (2017) meta-analysis revealed that the variable of the vocabulary elements taught did not significantly differentiate effect size values. Overall, the results indicate a need for further research on the influence of vocabulary knowledge type in vocabulary instruction studies.

Additionally, the methodological characteristics specific to the studies analyzed in meta-analyses (Kansızoğlu, 2017; Marulis & Neuman, 2010; Webb et al., 2023; Yun, 2011) have been identified as moderator variables. Webb et al.'s (2023) meta-analysis found that the incidental amount of vocabulary learning was affected by the implementation of a pilot test. Other meta-analyses (Kansızoğlu, 2017; Marulis & Neuman, 2010; Yun, 2011) examined how effect size varies according to sample size. Marulis and Neuman (2010) found that small group activities were effective in developing oral language skills, Yun (2011) reported that studies with larger sample sizes provided higher effect sizes, and Kansızoğlu (2017) concluded that sample size did not significantly differentiate effect size values. These conflicting findings suggest the need for further investigation of methodological characteristics in meta-analyses on vocabulary instruction. Furthermore, it is important to recognize that moderators other than the five evaluated in this study could contribute to heterogeneity. The location of the intervention, the method of participant selection, and the type of school (public, private or semi-private) are potential additional moderators that could be investigated.

Finally, variables such as sample size and vocabulary type were selected as meta-regression variables to better understand the effect sizes of vocabulary instruction interventions while considering multiple factors. The results showed that the explanatory power of sample size as a independent variable on the dependent variable was slightly higher than its explanatory power when combined with the number of vocabulary items taught. This suggests that sample size has the potential to be a more effective factor in explaining the dependent variable than the number of vocabulary items taught. Lin and Lin (2019) highlighted the critical role of sample size in quantitative meta-analysis and its direct connection to effect size. However, conducting vocabulary instruction studies with limited samples is interpreted as a factor that threatens generalizability (Hairrell, 2008; Kuhn & Stahl, 1998; Mahdi, 2018). In conclusion, these findings highlight the importance of considering sample size as a significant factor in future vocabulary instruction studies.

5. Limitations and Suggestions

This study has several limitations. First, the meta-analysis is limited to studies conducted in Turkish and at the undergraduate thesis level. This language constraint may introduce bias, potentially affecting the reliability of the findings. To improve the generalizability of the results, future meta-analyses should include studies published in various languages. Another significant limitation is the lack of reporting of certain information in the studies analyzed. Some studies did not report the number of vocabulary words taught, the individuals who conducted the intervention, or the method for determining the words, which led to the exclusion of these studies from the analysis. As a result, subgroup analyses that could have been performed with 43 studies were conducted with a smaller number. Additionally, this study focused only on the overall effect of interventions aimed at improving vocabulary on cognitive outcomes (e.g., achievement, skills) related to vocabulary acquisition. As a result, dependent variables such as attitudes toward Turkish lessons, attitudes toward vocabulary development, and motivation for vocabulary learning were excluded from the analysis. Future meta-analyses might examine these variables to provide a more comprehensive understanding of the impact of vocabulary interventions.

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Note: The meta-analyses included in the study are starred (*) in the list.

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Appendix 1. Descriptive Information on Studies Included in the Meta-Analysis

Author	*Pilot Study*	*Retention Test*	*Method for Determining Words*	*Vocabulary Output (Dependent Variable)*	*Sample Size*	*Number of Taught Vocabulary Words*
Akın (2018)	None	None	Literary book/text	Mixed	117	25
Akyıldız (2019)	None	None	Literary book/text & Proverb cards	Proverb Knowledge	148	15
Aydoğdu (2019)	None	None	Animation film	Vocabulary Knowledge	110	60
Balaban (2019)	None	None	Literary book/text	Combined	45	75
Bilgin (2018)	None	None	Textbook	Vocabulary Knowledge	53	NR
Bulut (2013)	None	None	Textbook / Frequency List	Mixed	125	53
Cingöz (2019)	None	Yes	Literary book/text	Vocabulary Knowledge	30	25
Çelik (2004)	None	None	Text adapted to the student's level	Mixed	190	NR
Çelikkol (2007)	None	None	Music books & Songs	Vocabulary Knowledge	87	100
Çetinkaya (2002)	Yes	None	Textbook	Mixed	77	15
Demirel-İşbulan (2010)	None	None	Textbook	Idiom knowledge	42	20
Durmaz (2020)	None	None	Literary book/text	Combined	50	10
Er (2013)	None	Yes	NR	Mixed	50	54
Genç-Ersoy (2017)	None	None	Textbook	Mixed	34	NR
Gül (2009)	None	None	Textbook	Mixed	62	30
Gülcan (2010)	None	None	Textbook	Idiom knowledge	80	27
Güney-Mürsel (2009)	None	None	Text adapted to the student's level	Mixed	61	41
İlhan (2016)	None	None	NR	Vocabulary Knowledge	60	NR
Kara (2018)	None	Yes	Literary book/text	Vocabulary Knowledge	48	41
Kazıcı (2008)	None	None	Literary book/text	Combined	106	28
Koçpınar (2018)	None	Yes	Textbook	Vocabulary Knowledge	71	NR
Kodan (2011)	None	None	Textbook	Vocabulary Knowledge	66	29
Kurt (2018)	None	None	Textbook	Combined	75	16
Okur (2007)	Yes	None	Literary book/text	Mixed	78	NR
Oruç (2011)	None	None	Textbook	Vocabulary Knowledge	12	13
Örge (2003)	Yes	None	Text adapted to the student's level	Idiom knowledge	85	20
Özaslan (2006)	None	None	NR	Combined	24	NR

Appendix 1 continued

Author	*Pilot Study*	*Retention Test*	*Method for Determining Words*	*Vocabulary Output (Dependent Variable)*	*Sample Size*	*Number of Taught Vocabulary Words*
Özer (2007)	None	None	Literary book/text	Mixed	80	50
Sevim (2019)	Yes	None	Textbook	Mixed	86	NR
Soylu (2020)	None	None	Textbook	Idiom knowledge	61	50
Şahin (2019)	None	None	Textbook	Idiom knowledge	29	10
Şenol (2011)	None	Yes	Textbook	Idiom knowledge	NR	10
Tağa (2018)	Yes	Yes	Textbook	Combined	76	80
Tanrıverdi (2019)	None	None	Textbook	Vocabulary Knowledge	20	30
Taşdemir-Bulut (2006)	None	None	Textbook	Mixed	50	29
Taşkın (2019)	None	None	Textbook	Mixed	44	110
Tek (2021)	None	None	Literary book/text	Idiom knowledge	80	NR
Tuğyan (2010)	None	None	NR	Vocabulary Knowledge	227	NR
Ulu (2019)	None	None	Textbook	Mixed	72	NR
Uysal (2020)	Yes	Yes	Textbook	Mixed	74	194
Varan (2017)	None	None	Literary book/text	Vocabulary Knowledge	36	43
Yegen (2020)	None	Yes	Literary book/text	Vocabulary Knowledge	128	NR
Yıldırım (2010)	None	None	Textbook	Mixed	69	NR

Appendix 2. Meta-analysis data and forest plot

Study name	Subgroup within study	Hedges's g	Standard error	Outcome	Variance	Lower limit	Upper limit	Z-Value	p-Value
Akın, 2018	Blank	1,811	0,219	söz varlığı (karma)	0,048	1,383	2,239	8,287	0,000
Akyıldız, 2019	Combined	2,334	0,158	söz varlığı (atasözü bilgisi)	0,025	2,024	2,644	14,744	0,000
Aydoğdu, 2019	Combined	1,466	0,152	söz varlığı (kelime bilgisi)	0,023	1,169	1,764	9,661	0,000
Balaban, 2019	Combined	0,768	0,121	Combined	0,015	0,530	1,006	6,322	0,000
Bilgin, 2018	Blank	0,105	0,271	söz varlığı (kelime bilgisi)	0,073	-0,426	0,636	0,388	0,698
Bulut,2013	Blank	0,428	0,180	söz varlığı (karma)	0,032	0,076	0,781	2,381	0,017
Cingöz, 2019	Blank	3,166	0,542	söz varlığı (kelime bilgisi)	0,293	2,105	4,227	5,846	0,000
Çelik, 2004	Blank	1,164	0,156	söz varlığı (karma)	0,024	0,857	1,470	7,442	0,000
Çelikkol, 2007	Combined	0,673	0,217	söz varlığı (kelime bilgisi)	0,047	0,248	1,099	3,104	0,002
Çetinkaya, 2002	Combined	0,362	0,186	söz varlığı (karma)	0,035	-0,004	0,727	1,941	0,052
Demirel İşbulan, 2010	Combined	0,839	0,184	söz varlığı (deyim bilgisi)	0,034	0,477	1,200	4,551	0,000
Durmaz, 2020	Blank	2,327	0,374	Combined	0,140	1,595	3,059	6,230	0,000
Er, 2013	Blank	1,878	0,336	söz varlığı (karma)	0,113	1,220	2,536	5,592	0,000
Genç Ersoy, 2017	Blank	0,613	0,344	söz varlığı (karma)	0,118	-0,061	1,286	1,783	0,075
Gül, 2009	Blank	1,401	0,281	söz varlığı (karma)	0,079	0,851	1,951	4,993	0,000
Gülcan, 2010	Blank	2,051	0,274	söz varlığı (deyim bilgisi)	0,075	1,513	2,589	7,473	0,000
Güney Mürsel, 2009	Blank	0,764	0,262	söz varlığı (karma)	0,069	0,250	1,278	2,915	0,004
İlhan, 2016	Blank	0,934	0,269	söz varlığı (kelime bilgisi)	0,072	0,407	1,461	3,476	0,001
Kara, 2018	Blank	3,049	0,421	söz varlığı (kelime bilgisi)	0,177	2,223	3,875	7,238	0,000
Kazıcı, 2008	Blank	0,273	0,194	Combined	0,038	-0,107	0,653	1,407	0,160
Koçpınar, 2018	Blank	0,895	0,247	söz varlığı (kelime bilgisi)	0,061	0,412	1,378	3,630	0,000
Kodan, 2011	Combined	0,560	0,176	söz varlığı (kelime bilgisi)	0,031	0,215	0,904	3,186	0,001
Kurt, 2018	Combined	1,748	0,237	Combined	0,056	1,284	2,212	7,386	0,000
Okur, 2007	Blank	1,204	0,244	söz varlığı (karma)	0,060	0,726	1,682	4,933	0,000
Oruç, 2011	Blank	2,993	0,782	söz varlığı (kelime bilgisi)	0,612	1,459	4,526	3,824	0,000
Örge, 2003	Blank	2,158	0,341	söz varlığı (deyim bilgisi)	0,116	1,491	2,826	6,338	0,000
Özaslan, 2006	Blank	1,002	0,420	Combined	0,176	0,179	1,825	2,386	0,017
Özer, 2007	Blank	0,674	0,228	söz varlığı (karma)	0,052	0,228	1,120	2,959	0,003
Sevim, 2019	Combined	0,270	0,213	söz varlığı (karma)	0,045	-0,147	0,687	1,268	0,205
Soylu, 2020	Blank	1,472	0,287	söz varlığı (deyim bilgisi)	0,082	0,910	2,034	5,137	0,000
Şahin, 2019	Blank	2,703	0,506	söz varlığı (deyim bilgisi)	0,256	1,710	3,695	5,337	0,000
Şenol, 2011	Blank	0,907	0,322	söz varlığı (deyim bilgisi)	0,104	0,275	1,539	2,814	0,005
Tağa, 2018	Combined	0,457	0,145	Combined	0,021	0,172	0,742	3,141	0,002
Tanrıverdi, 2019	Blank	0,603	0,439	söz varlığı (kelime bilgisi)	0,193	-0,257	1,463	1,375	0,169
Taşdemir Bulut, 2006	Blank	2,160	0,352	söz varlığı (karma)	0,124	1,470	2,851	6,131	0,000
Taşkın, 2019	Blank	1,121	0,319	söz varlığı (karma)	0,102	0,495	1,746	3,509	0,000
Tek, 2021	Blank	0,231	0,222	söz varlığı (deyim bilgisi)	0,049	-0,204	0,667	1,042	0,298
Tuğyan, 2010	Combined	0,809	0,079	söz varlığı (kelime sayısı)	0,006	0,653	0,965	10,185	0,000
Ulu, 2019	Blank	0,773	0,242	söz varlığı (karma)	0,059	0,299	1,247	3,195	0,001
Uysal, 2020	Blank	1,252	0,252	söz varlığı (karma)	0,064	0,758	1,746	4,966	0,000
Varan, 2017	Blank	2,836	0,467	söz varlığı (kelime bilgisi)	0,218	1,920	3,751	6,070	0,000
Yegen, 2020	Combined	0,531	0,126	söz varlığı (kelime bilgisi)	0,016	0,285	0,777	4,224	0,000
Yıldırım, 2010	Combined	0,793	0,214	söz varlığı (karma)	0,046	0,375	1,212	3,712	0,000
		1,179	0,099		0,010	0,985	1,374	11,888	0,000

Hedges's g and 95% CI