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Effects of Instructional Intervention Programs on Reading Skills of Students with Reading Difficulties

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Evaluating the impacts of instructional intervention programs on students with reading difficulties is important for setting guidelines to teachers, researchers, and policy-makers. The aim of this research is to examine how these interventions initiatives impact the reading abilities of students diagnosed with reading difficulties (RD). 38 impact sizes obtained from 17 meta-analysis studies are analysed with second order meta-analysis method. These studies included are carried out between 1999 and 2023, and focus on the effects of instructional intervention programs on the reading abilities of individuals who experience difficulties in reading. Finally, in the analysis, it is decided that the impact of instructional intervention programmes on students with RD is mid-range (g= .50). Also, instructional intervention programs caused important differences according to the type of intervention, quality level, and the year of publication on the reading abilities of individuals with RD. It is determined that comprehension strategy instruction (CSI) intervention programs are more efficient than foundational reading skills instruction (FRSI) and multicomponent instruction (MI) intervention programs. It is necessary to make more experimental studies to determine if instructional interventions cause meaningful differences in terms of the characteristics of participant students. It can also be beneficial to carry out primary meta-analysis studies that test the impact of instructional interventions on the reading abilities of individuals with RD who are determined with standardized tests.

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Introduction

Reading difficulties are specific difficulties characterized by serious and permanent problems in learning reading skills (American Psychological Association [APA], 2013). Reading difficulties are a common learning difficulty, which approximately constitutes 90% of all learning problems (Bender, 2016). RD is characterized by having problems reading or spelling words correctly or fluently (Fletcher et al., 2019). According to a different definition, it is a type of difficulty experienced by students in the processes of identifying words, solving codes, and spelling (Galuschka et al., 2020).

Reading difficulties are approximately between 5% and 17.5% (Peterson & Pennington, 2012). This variation in the rates of extensity can be explained with a few factors. Firstly, having different definitions in the literature might cause different ratios. Secondly, environmental factors (e.g. socio-economic situation, region) and other factors (e.g. grade, insufficiency) might affect the risk of experiencing reading difficulty (Yang et al., 2022).

Many students with RD, experiencing failure in reading, are at high-risk in terms of academic, professional, and social problems (Volkmer & Schulte-Körne, 2018). Students with RD have low academic success, higher reading anxiety, lower positive well-being, and negative attitudes (Hutton et al., 2021). When necessary intervention studies aren't carried out with these students at early periods, they fall behind their peers who have typical development features (Bender, 2016). Students who experience difficulty in reading skills have negative performance in some other classes (Bender, 2016) as they have difficulty reading texts in their textbooks used in learning other lessons. There are different types of instructional interventions developed to backing the reading abilities of individuals with RD. These intervention programs have had different effects on students. Deciding which interventions effectively improve the reading abilities of individuals with RD is essential.

Meta-analysis studies on reading difficulties generally include experimental research studies. It is necessary to make second order meta-analysis studies that synthesize the results of primary meta-analysis which analyse the impacts of reading intervention programs on students with RD. Sampling errors that occur in primary meta-analysis studies are removed in second order meta-analysis studies (Schmidt & Oh, 2013). In second order meta-analysis studies, it is possible to calculate how much of the variance in mean impact sizes results from sampling error. On the other hand, it is possible to reach correct impact size values with second order meta-analysis and reliability among meta-analyses can be calculated through mean impact size values (Schmidt & Oh, 2013).

It is necessary to determine, support, and use effectual intervention programs to support the reading skills of individual with RD (Hall et al., 2022). In this context, it is significant to evaluate studies that analyze the instructional intervention programs developed for bettering the reading skills of individuals with RD. Articles and the literature about the issue should be carefully analysed and inferences should be carefully made. Second order meta-analysis is an efficient method for this purpose. In this method, impact sizes of primary meta-analyses focusing on similar issues are combined and summarized (Schmidt & Oh, 2013).

Second order meta-analysis enables researchers to make more comprehensive studies when compared to the primary meta-analysis method (Cooper & Koenka, 2012). This method allows for making quality evaluations of primary meta-analysis studies (Bernard, Borokhovski, Schmid, & Tamim, 2014). Schmidt and Oh (2013) state that it is possible to make more reliable estimates by evaluating the reliability of the differences between the effect sizes obtained from

primary meta-analysis studies with the second order meta-analysis method. Finally, the results of second order meta-analysis studies ensure information to researchers and policy-makers (Polanin, Maynard, & Dell, 2017).

In the literature, second order meta-analysis studies on the effect of instructional interventions on the reading skills of students with RD were limited. With the application of a second order meta-analysis study, impact sizes of primary meta-analysis studies are combined and evaluated, and accurate estimations are made. At the same time, the qualities of the primary meta-analysis studies are evaluated with the second order meta-analysis study. On the other hand, interventions that are efficient in bettering the reading abilities of individuals with RD are identified. Identifying the instructional interventions that are productive in terms of improving the reading skills of such individuals is important for presenting guidelines to policy-makers, researchers, and teachers. Finally, variations in the efficiency of these programs on students with RD in the scope of second order meta-analysis studies in terms of moderator variables are determined.

Several factors make this study important. Firstly, studies examining reading intervention programs were analysed by second-order meta-analysis method and effective reading intervention programs were identified. The existing contradictory results in the literature were analysed by combining them with the meta-analysis method and the existing literature was expanded. Secondly, the identification of effective intervention programs will guide researchers working in this field. Thirdly, effective intervention programs are important in terms of providing quality education to teachers in the teaching process. Indeed, effective intervention programs can support the reading and reading comprehension skills of students with learning disabilities. In this way, students can continue their education without falling behind their peers.

Reading Intervention Programs

Instructional intervention programs designed and developed for students with RD improve the reading outputs of students. Instructional intervention programs have positive impacts on the reading abilities of different participant groups such as LD, RD, and at-risk RD (Scammacca, Roberts, Vaughn, & Stuebing, 2015). Reading abilities of individuals with RD are supported by various instructional interventions that have been developed (Hall et al., 2022; Scammacca et al., 2015). Instructional intervention programs generally focus on basic skills (Al Otaiba et al., 2022) and understanding processes (Scammacca et al., 2015); besides, there are some multi-component instructional intervention programs focusing on both basic skills and understanding (Swanson et al., 2014). Al Otaiba et al. (2022) focused on intervention programs delivered one-to-one or in small groups. They showed that intervention programs improved reading and reading comprehension skills of primary school students. Swanson et al (2014) stated that reading interventions positively affect students with learning disabilities.

Instructional interventions focusing on basic skills include training about phonemic awareness, phonetics, word identification, fluency, and spelling (Donegan & Wanzek, 2021). In this study, the effects of small-group and large-group teaching intervention programs on students' reading skills were examined. As a result of the research, it was determined that the intervention programs applied in the form of small-group teaching had a greater effect. Instructional intervention programs for fluency are efficient in improving reading abilities (Zimmerman, Reed, & Aloe, 2019). Fluency intervention includes training about the processes of over-reading in which students read the same text more than once with the support of teachers or peers besides reading without repetition by focusing on reading more than one text

(Zimmermann, Reed, & Aloe, 2021). Both intervention types improved the reading abilities of students with RD (Lee & Yoon, 2017).

Intervention programs that focus on the instruction of understanding strategy are efficient in improving the reading abilities of individuals with RD (Donegan & Wanzek, 2021). Instruction of understanding strategy includes teaching the issues of determining the main idea, making self-regulation, and carrying out following processes (Solis et al. 2012). Multi-component instructional interventions focusing on basic skills and understanding positively impacted the reading abilities of individuals with RD (Wanzek et al., 2010). On the other hand, more studies are needed on the efficiency of multi-component instructional interventions (Donegan& Wanzek, 2021).

Meta-analysis focusing on the analysis of reading intervention programs

Studies in the literature investigate the impact of instructional interventions on individuals with RD across diverse grade levels. However, the findings of these studies are generally different from one another. Most of the instructional intervention programs focus on primary school (Hall et al., 2022; Donegan & Wanzek, 2021; Galuschka et al., 2020; Lopes et al., 2024; Wanzek et al., 2016) and high school (Daniel, Capin, & Steinle, 2021) levels and the effects are determined. In meta-analysis studies, participant groups selected to assess the effects of instructional interventions include individuals with learning disabilities (Kaldenberg, Watt, & Therrien, 2015), reading disabilities (Galuschka et al., 2020), and those at risk of reading disabilities.

According to the results of studies focusing on analysing the efficiency of instructional intervention programs, the programs had positive effects on the reading abilities of individuals with RD (Striftou et al., 2024). Meta-analysis studies analyze the effects of different intervention programs (foundational skills instruction, comprehension strategy instruction, and multi-component instruction) on reading skills. In these studies, researchers reported that impact sizes varied between low, medium and high levels (Donegan & Wanzek, 2021; Sucena et al., 2024; Wanzek et al., 2016).

Research Purpose and Questions

This second order meta-analysis study has two main purposes. The first purpose is to analyse the impact of reading interventions developed for individuals with RD, on their reading skills. The second purpose is to determine if the impact of these RD intervention programs on reading skills varies according to moderator variables (participants' characteristics, grade, report type, location, instruction and quality). For this purpose, the below-mentioned questions are asked and followed.

(1) How do instructional intervention programs affect the reading abilities of individuals with RD?
(2) Does the effect of instructional interventions on the reading abilities of individuals with RD vary according to moderator variables?

Method

In this study, the second order meta-analysis method was utilized to identify instructional interventions that were effective on the reading skills of individuals with RD.

Second order meta-analysis is a type of analysis that takes the results of existing meta-analyses one step further. As in first order meta-analysis, second order meta-analysis examines and synthesizes the results of multiple meta-analysis studies on a topic (Polanin et al., 2017).

Data collection process

Research data were collected through different databases (Web of Science, Sage Journals, Scopus, Taylor & Francis Online, Science Direct and Wiley Online Library). Advanced research sections of the database are used to carry out the electronic research process. Keywords used in the first line in the "search" section are "learning disabilities (difficulties)", "reading disabilities (difficulties)" and "dyslexia". "Reading intervention", "reading comprehension", "reading fluency", "spelling instruction" "reading instruction", and "instructional intervention" are the keywords used in the second line. "Systematic review", "meta-analysis" and "review articles" are used in the third line.

On the other hand, journals where articles on learning disabilities are widely available were also manually searched. According to the literature review, the earliest published article is from 1999; therefore, the start date of the review is 1999 and the end date is February 2023.

There are 222 articles about the issue according to the review process results. Articles determined at the end of the electronic and manual reviews are analysed in two phases. Firstly, the summaries of determined articles are analysed. After analysing the summary sections, the articles are completely analysed. Articles are excluded according to the exclusion criteria. As a result of the scans, 17 articles were identified. The screening process is given in detail in Figure 1.

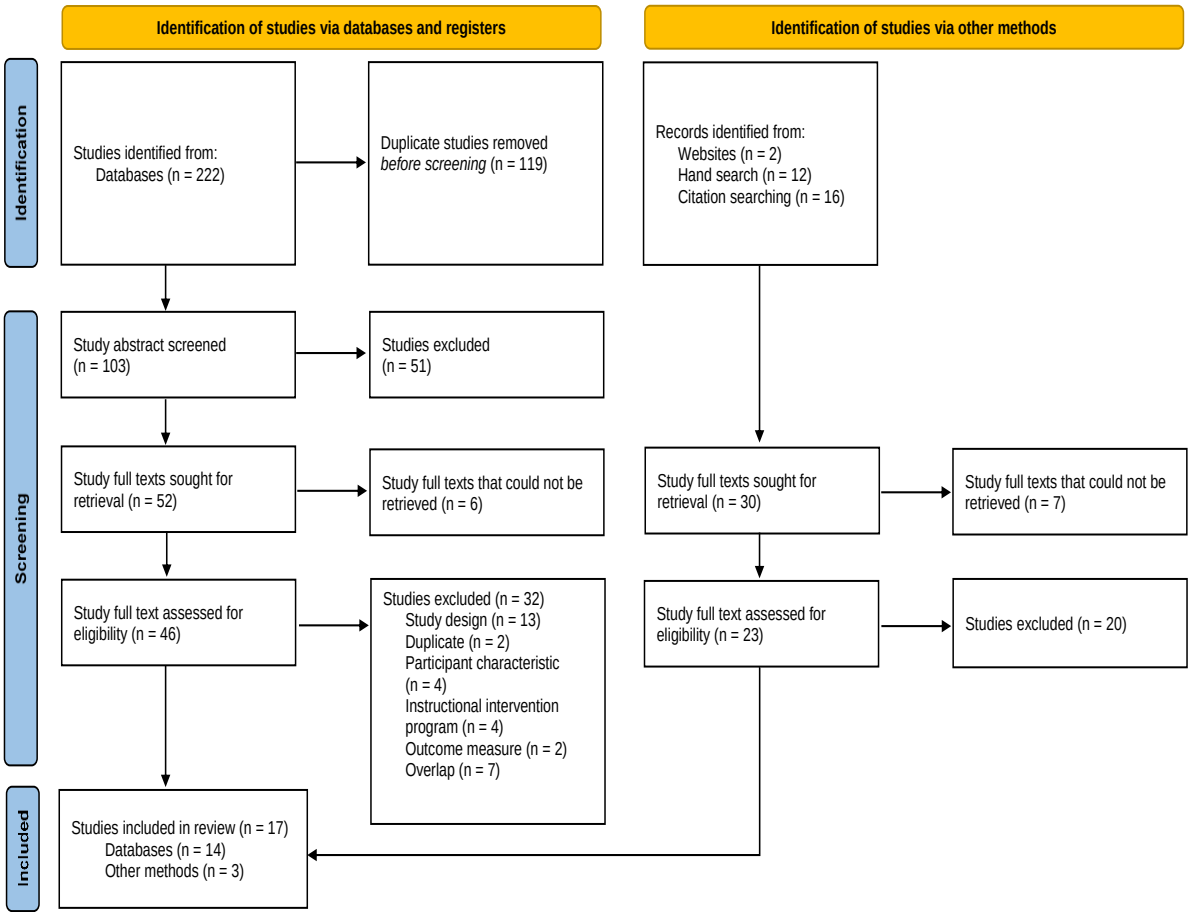

Figure 1. Search flow diagram

Inclusion criteria

The following criteria were considered while determining which studies should be included in the analysis.

(1) Intervention studies focusing on the effects on reading skills of individuals with RD,
(2) Studies in which the intervention programs developed for students with RD are clearly defined,
(3) Studies including participant groups with LD, RD, and at-risk RD,
(4) Studies including necessary statistical data for calculating impact size,
(5) Studies whose study outputs include a minimum of one reading measure,
(6) Meta-analysis studies analysing the experimental studies are determined.

Exclusion Criteria

The determined studies are excluded according to the criteria mentioned below.

(1) Studies analysing the impacts of interventions advanced for students with RD on different outputs (motivation, perception, etc.),
(2) Studies in which instructional intervention programs aren't mentioned or studies that do not involve an intervention,

(3) Studies with a score of 23 or less on the (R-AMSTAR [Revised Assessment of Multiple Systematic Reviews]) scale used for publication quality,
(4) Studies that have more than a 25% overlapping ratio with the studies they include are excluded Cooper & Koenka (2012). Meta-analysis studies with an overlap rate below 25% are considered independent studies.

Overlapping problem

Overlapping is one of the most significant problems of second order meta-analysis studies. When primary research included in different meta-analysis studies are the same, it means that there is overlapping. When meta-analysis studies overlapped at a high level (25% or more), the more comprehensive and up-to-date meta-analysis study was selected and the others were excluded from the process. Included and excluded studies which are carefully chosen after a process of comparison by the first and second authors are given in Table 1.

Table 1. Inclusion and exclusion on the grounds of overlap

Included	Excluded	Percentage (%)
Berkeley, Scruggs & Mastropieri (2010)	Flynn, Zheng & Swanson (2012)	30
	Edmonds et al. (2009)	27
Donegan & Wanzek (2021)	Zimmermann, Reed & Aloe (2021)	38
Hall et al. (2022)	Denton et al. (2022)	36
	Nilvius et al. (2021)	50
	Gersten (2020)	32
	Wanzek et al. (2018)	44
	Wanzek et al. (2016)	35

Coding procedure

A coding page is created by researchers to systematically collect the study information. While developing the coding page, we considered the Syntheses of Educationally Relevant Instructional Studies Guide developed by Vaughn et al. (2014). All studies are encoded by the first author. After this step, all studies are encoded independently by the second author, and coding reliability among interrater is calculated. Encoding reliability among interrater is determined by calculating Cohen's kappa reliability coefficient. The conclusion percentage for encoding instructional intervention programs and other moderators is calculated as 81%. All contradictions are solved through discussions and expert opinions. The opinion of an expert researcher who has studied developing the reading abilities of individuals with RD in the special education department is taken.

Coding was carried out by two researchers. It was observed that the inconsistencies between the coding were generally between the variables of intervention type and participant character. Inconsistencies in intervention type have been discussed among researchers. The final decision on intervention types was made by taking into account the definitions put forward by Donegan & Wanzek (2021) and Denton et al., (2022), which are the more cited sources in the literature. Again, if there were inconsistencies among the participant characters, final decisions were made with reference to (World Health Organization [WHO], 2005) or DSM-5 (APA, 2013).

Intervention type

Instructional intervention programs are encoded based on the encoding process of Donegan & Wanzek (2021). These programs are encoded as foundational reading skills instruction (fluency, phonics, or phonemic awareness), comprehension instruction (comprehension and vocabulary), and multi-component instruction (both foundational skills and comprehension).

If studies include, graph phonemic knowledge, alphabetic knowledge, decoding, recognition of orthographic patterns, phonological awareness, morphology, word recognition, fluency, and spelling instructions, they are encoded as foundational reading skills instruction (Denton et al., 2022). If studies include the instruction of strategy for understanding, they are encoded as comprehension strategy instruction. For example, within the text-based questioning process, discussions regarding the text and students' predictions based on illustrations and prior knowledge following reading are categorized as comprehension instruction (Denton et al., 2022). Instructional intervention programs including education components such as meta-cognition, answering questions, graphic and semantic organizers, recognizing story structure, generating questions, and summarizing, are encoded as comprehension strategy instruction. If studies include both foundational reading skills and comprehension strategy instruction, they are encoded as multi-component instruction.

Participant characteristics

Different participant groups are involved in the studies about instructional intervention programs. Participant groups are encoded as LD, RD, and at-risk RD according to their features. Participants included in the classification of reading difficulty according to the criteria of ICD-10 (World Health Organization [WHO], 2005) or DSM-5 (APA, 2013), are encoded as students with RD by researchers. On the other hand, participants whose reading targets are determined in the scope of the Individualization Education Program (IEP) are encoded in the same way.

Researchers encoded the students who obtained scores below 25. percentile in a standard reading test as “at-risk RD” (Hall et al., 2022). While determining students with RD, the ones who are at or below the 25. percentile level in the tests about norm-referenced word-reading, spelling, or basic skills (word reading, spelling, text reading accuracy, fluency) tests is taken into consideration. Students at-risk RD (below the 25. percentile) represent a heterogeneous group including students with RD. As there is insufficient information in meta-analysis studies, there are no definite limitations between these two groups. Thirdly, students who are represented as LD and who have difficulty in reading are encoded as individuals with LD.

Quality level of meta-analysis

The R-AMSTAR scale was used to determine the quality of the included meta-analysis studies. The scale was developed by Kung et al. (2010). As articles 8C and 8D in the scale are used in clinical practices as a part of medical processes, they aren't scored. While the R-AMSTAR scale is evaluated, the encodings are 34 to 44= high, 23 to 33=medium, 12 to 22=low, and 0 to 11 insufficient (Young, 2017).

Grade level

The meta-analysis studies included in the analysis were coded into two categories, K8 and K12, according to the grade level moderator variable.

Bias status

Primary meta-analysis research is encoded according to the findings about publication bias. For example, if there is no publication bias the code is "No", if there is publication bias, the code is "Yes" (but trivial), and if there is no finding about publication bias, the code is "NR" (not reported).

Report type included

Included meta-analysis studies are coded as articles if they analyze only articles or as mixed if they analyze different types of reports, such as doctoral dissertations.

Year range

The year of publication is regarded as the reference and the encoding is made accordingly. Coding result, features of 17 studies that meet the criteria of inclusion are given in Table 2.

Table 2. Features of the included studies

	ES	LL	UL	Grade	Report	Participant Characteristic	Intervention	Outcome	Quality	Publication Bias	Year Range
Galuschka et al. (2020)	0,63	0,33	0,92	K8	Article	RD	FRSI	Reading	High	Yes	1989-2018
	0,62	0,22	1,02								
	0,61	-0,24	1,46								
Lee, et al. (2022)	0,47	0,36	0,59	K12	Mixed	RD	CSI	Reading	High	No	Before 2021
Berkeley, et al. (2010)	0,75	0,58	0,92	K12	Mixed	LD	CSI	Reading Comprehension	Median	NR	1995-2007
	0,62	0,24	1,00								
	0,48	0,18	0,77								
	0,82	0,25	1,40								
Daniel et al. (2021)	0,67	0,10	1,25	K12	Mixed	Mixed	CSI	Reading Comprehension	High	NR	1996-2019
Donegan & Wanzek (2021)	0,18	-0,09	0,44	K8	Article	Mixed	FRSI	Reading	High	No	1988–2019
	0,29	0,10	0,49				CSI				
	0,17	0,06	0,29				MI				
	0,36	0,10	0,61				FRSI	Reading comprehension			
	0,16	0,01	0,31				MI				
Galuschka, et al. (2014)	0,27	-0,24	0,80	K12	Mixed	RD	FRSI	Reading performance	High	No	Until 2013
	0,32	0,17	0,46								
	0,30	-0,10	0,70								
	0,17	-0,18	0,53				CSI				
Buzick & Stone (2014)	0,56	0,42	0,70	K12	Article	Mixed	CSI	Reading	Median	No	1998-2013
Kaldenberg et al. (2015)	0,98	0,69	1,27	K12	Article	LD	CSI	Reading comprehension	High	NR	1980-2011
Lee & Yoon (2017)	1,41	0,99	1,41	K12	Mixed	RD	FRSI	Reading fluency	High	NR	1990-2014
Marulis & Neuman (2013)	0,87	0,71	1,04	K8	Article	At risk RD	CSI	Vocabulary	High	No	NR
	0,34	0,17	0,50	K8	Article	At risk RD	FRSI		High	No	

Hall, et al. (2022)	0,37	0,28	0,46	K8				Reading skills (PA, reading, reading comprehension)			1980-2021
	0,38	0,28	0,46	K8							
Rice, et al. (2022)	0,36	0,07	0,65	K12	Mixed	At risk RD	FRSI	Reading skills (phonological awareness)	High	No	NR
	0,79	0,56	1,02	K12							
	0,49	0,29	0,68	K12							
Roberts, et al. (2020)	0,60	0,30	0,90	K12	Mixed	RD	FRSI	Reading skills (phonological awareness, word reading)	High	No	1975-2018
	0,44	0,17	0,71	K12			CSI				
Goodwin & Ahn (2010)	0,33	0,18	0,47	K12	Mixed	RD	FRSI	Reading skills (phonological awareness, fluency, comprehension)	High	No	1980-2009
Scammacca, et al. (2015)	0,74	0,50	0,98	K12	Article	RD	FRSI	reading comprehension	High	No	1980-2011
	0,30	0,10	0,50	K12							
	0,33	0,08	0,58	K12							
	1,58	1,11	2,05	K12							
	0,20	0,10	0,30	K12							
Swanson (1999)	0,72	0,68	0,77	K12	Mixed	RD	CSI	reading comprehension	Median	No	1963-1997
Wood, et al. (2018)	0,35	0,14	0,56	K12	Article	RD	CSI	reading comprehension	High	Yes	NR

Note: UL=Upper Limit; ES=Effect Size; LL=Lower Limit; FRSI=Foundational Reading Skills Instruction; CSI=Comprehension Strategy Instruction; MI=Multicomponent Instruction; RD=Reading Difficulties; LD=Learning Difficulties; PA=Phonological Awareness; NR=Not Reported.

Data analysis

The random effect model is used in statistical analyses considering the diversity of primary meta-analysis studies (Borenstein et al., 2011).

Effect size choice

The objective of this research is to assess the effectiveness of instructional intervention programs on the reading skills of individuals with RD. Impact sizes about independent instructional intervention programs reported in primary meta-analysis research are encoded for this purpose. Researchers meeting the inclusion criteria of this research often reported Hedge's g (n=14) and rarely Cohen d (n=3) impact size indexes. Hedge's g index is the corrected value of Cohen's d value. In other words, when the sampling size is big enough, Hedge's g value is equal to Cohen's d value (Marfo & Okyere, 2019). It is assumed that the sample sizes of primary meta-analysis studies included in this research are adequate.

Publication bias analyses

Publication bias is an significant problem in meta-analysis research. It is related to the reliability of computed effect size (Mathur & Vander Weele, 2021). In this research, Duval & Tweedie, and trim and fill analysis (DTTF) techniques, funnel plot analysis, Egger's regression test are employed to examine the publication bias of the dataset created based on the inclusion criteria.

Heterogeneity analyses

Q statistics are used to determine the total heterogeneity within the dataset, while the I^2 statistics are employed to assess the overall level of heterogeneity. On the other hand, moderator analysis is used to control if impact sizes vary according to different moderator groups. Inter-group statistics (Qb) is used to test the difference between groups in moderator analysis. The total heterogeneity of the data set and the heterogeneity between groups were analysed statistically and the statistical significance level was considered as $p < .05$. The heterogeneity level (I^2) was interpreted according to Borenstein (2017). If the moderator variable is constant (e.g. publication year), the meta-regression technique is preferred in moderator analysis. For example, the analysis of whether or not there is a difference between studies in terms of their publication year is based on the meta-regression method.

Findings

The effect size of k=38 was generated from n=17 primary meta-analysis studies included in this study. The effect sizes range from ES = 0.16 to ES = 1.58. The mean effect size is calculated as ES = 0.50. According to this value, the impact of instructional intervention programs on the reading skills of students with RD is medium level. The obtained effect size value reveals that instructional intervention programs are more effective than traditional teaching models in increasing students' reading achievement. The total heterogeneity amount of the dataset is Q(total)=342.69 ($p<.001$) and the heterogeneity level is I^2=89.20. According to this, the distribution of impact sizes makes the dataset highly heterogeneous.

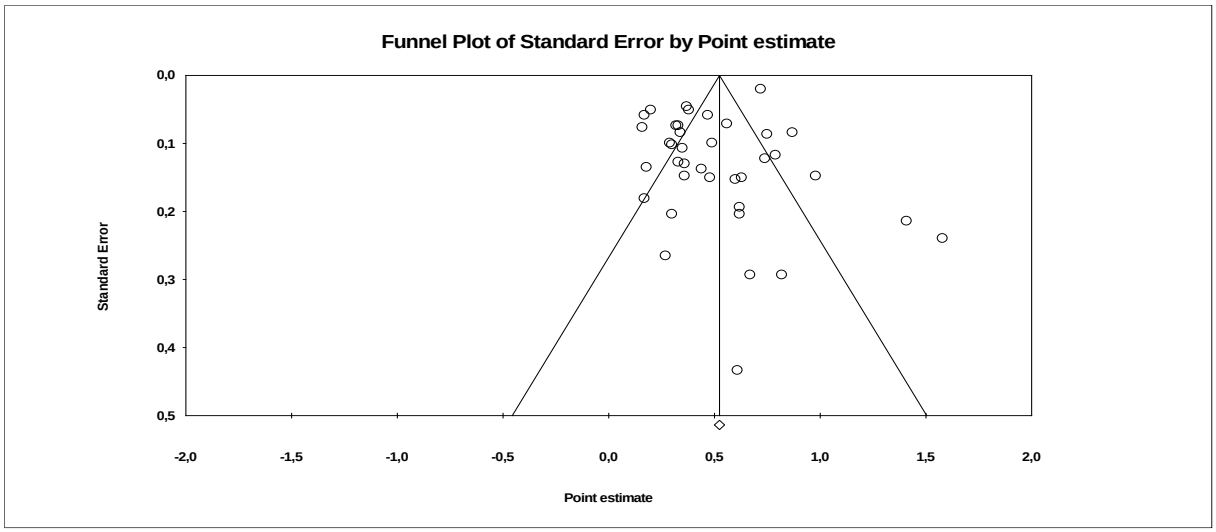

Figure 2. Funnel plot

On the other hand, whether or not the calculated impact size is affected by publication bias is tested. A funnel plot graphic about the distribution of impact sizes is given in Figure 2. It is noted that the distribution of the funnel plot graph appears to be nearly symmetrical according to standard deviations. Furthermore, Egger's regression test indicates no evidence of publication bias (intercept=-93, t=1.15, p=.26). Besides, the DTTF result indicates that there is trivial publication bias. According to DTTF analysis results, if 2 studies are added to the right side of the mean effect size, the distribution is symmetrical.

According to DTTF, the corrected mean impact size is ES=.52 LL=.43 UL=.60 (Q total=366.43). There is an insignificant difference between the observed impact size and corrected impact size (ES corrected – ES observed=.02). Heterogeneity and moderator analyses of the dataset are given in Table 3.

Table 3. Moderator and heterogeneity analysis of the dataset

Moderator	k	ES	LL	UL	Qb	df	p
Intervention type[a]							
FRSI	22	.47	.38	.56			
CSI	14	.58	.47	.69			
MI	2	.17	-.09	.42	9.10	2	.01
Participant characteristic[b]							
RD	25	.49	.39	.60			
LD	7	.69	.48	.90			
At risk RD	6	.34	.14	.54	5.53	2	.06
Grade level							
K12	26	.55	.45	.65			
K8	12	.39	.25	.53	3.20	1	.07
Quality							
High	32	.46	.38	.54			
Median	6	.65	.47	.83	3.68	1	.05
Bias status							
No	27	.44	.34	.53			
NR (not reported)	7	.81	.59	1,03			
Yes (but trival)	4	.53	.23	.83	9.13	2	.01
Report type							
Article	20	.45	.35	.56			
Mixed	18	.54	.43	.66	1.22	1	.27

Note: UL = Upper Limit; LL = Lower Limit; ES = Effect Size; k = number of effect sizes; Qb = heterogeneity of between group; df = degrees of freedom; p = significant estimates at p < .05.
[a]FRSI=Foundational Reading Skills Instruction. CSI=Comprehension Strategy Instruction. MI=Multicomponent Instruction.
[b]RD=Reading Difficulties. LD=Learning Difficulties.

Mean impact sizes are statistically different according to the intervention type used in instructional intervention programs (Qb=9.10, df=2, p < .05). MI (ES=.17) and FRSI (ES=.47) program types' mean impact sizes are low-level; CSI (ES=.58) program types' impact is medium-level. Primary meta-analysis researchers' mean impact sizes according to quality level statistically vary (Qb=3.68, df=1,p =.05). Primary meta-analysis researchers that are of high-quality produce low-level impact size (ES=.46) while medium-level quality studies (ES=.65) produce medium-level impact size. The mean impact size of primary meta-analysis studies statistically varies according to the publication bias (Qb=9.13, df=2, p < .05). Primary meta-analysis studies that do not have publication bias (ES=.44) produced low-level, research that has insignificant level publication bias (ES=.53) produced medium-level and studies that do not have publication bias analysis (ES=.81) produced high-level impact size.

On the other hand, some interesting findings about the sub-groups about which there is no statistical difference are mentioned below. It is observed that the instructional intervention programs are more efficient in LD participant groups when compared to the other groups (ES=.69). The group with K8 education level (ES=.39), included by the primary meta-analysis research, produced a lower impact size when compared to K12 group (ES=.55). Namely, it can be said that there is a lower impact on basic education level.

Similarly, it is determined that there is a statistically meaningful negative relationship between publication years and impact sizes (B=-.02, p< .05). In other words, the value of impact sizes decreases when the year of publication is more current (closer to today).

Discussion

The primary aim of this research is to analyze the effects of instructional interventions on the reading abilities of individuals with RD. Additionally, it seeks to investigate whether the impact of these interventions on the reading abilities of students with RD varies based on moderator variables.

Effects of instructional interventions on reading skills

This research concludes that instructional intervention programs have a medium and positive impact on the reading abilities of students with RD (ES=.50). This finding suggests that instructional intervention programs enhance the reading abilities of students with RD. It is observed that there are improvements in the reading abilities of individuals with RD when they are supported by instructional intervention programs (Scammacca et al., 2015).

Effects of instructional interventions on reading skills according to moderator variables

Intervention type

In this study, it is observed that instructional interventions lead to a significant improvement in the reading abilities of students with RD, particularly in terms of the type of intervention. This finding indicates that different instructional intervention programs affect the reading abilities of individuals with RD. Different characteristics of students with RD could be the reason for this difference. Different interventions are necessary for developing the reading abilities of these individuals (Hall et al., 2022).

This research, it is determined that CSI (ES = .58) interventions are more effective on the reading abilities of individuals with RD when compared to FRSI (ES=.47) MI (ES=.17) intervention programs. It can be said that CSI-focused intervention programs are more effective in terms of the reading abilities of these students. It is observed that there are different impact sizes in studies focusing on if there the effect of instructional intervention programs on the reading abilities of individuals with RD varies according to the intervention type. CSI-focused intervention programs had impact sizes ranging from low to medium levels (Fuchs et al., 2018). CSI intervention programs that focus on the main idea and summarization improved the reading abilities of students with RD. Different impact size values reported in research can be explained by the factor of publication year. Students with RD tend to have important deficiencies in basic reading abilities rather than understanding in older studies. In contrast to this situation, students tend to have difficulty in understanding rather than basic skills in more current studies (Donegan & Wanzek, 2021).

In this research, it is determined that FRSI-focused interventions have a medium-level effect on the reading abilities of individuals with RD. It can be said that FRSI-focused programs improved the reading abilities of individuals with RD. There are some different findings about the effects of these programs on students with RD. This difference might be resulting from the measurement type used for determining reading abilities. For instance, it is reported that non-standardized reading outcomes of an intervention program including education about phonemic

awareness, phonetics, spelling, fluency, and text-reading caused high and important impact size (Keller et al., 2019). On the other hand, the reason for this difference might be the fact that there are different pieces of training in FRSI intervention programs (e.g. phonetics, fluency, spelling, etc.).

According to the results of this study, the instructional intervention program that has the lowest impact on the reading abilities of individuals with RD is the MI intervention program. The reason behind this low impact size of the MI intervention program might be the fact that the study included in the analysis in calculating the impact size is limited. Studies analysing instructional intervention programs generally focus on CSI and FRSI intervention programs. Only two impact sizes focus on MI intervention programs. Low MI might be related to the complexity of reading abilities. On the other hand, it can be a complicated process for students who have difficulty in learning and reading. When these issues are taken into consideration, instructional intervention programs prepared for students with RD should focus on their basic reading and understanding skills. On the other hand, Studies with big samplings are necessary to understand the efficiency of MI intervention programs in terms of reading abilities. MI intervention programs can be improved for meeting the reading necessities of students with RD (Donegan & Wanzek, 2021). Education in MI intervention programs includes both basic reading abilities training and understanding and word knowledge training (Donegan & Wanzek, 2021). For instance, training focusing on text fluency is generally given with the teaching of understanding. In addition to this, a few intervention programs include decoding instruction which focuses on the word level and extends to the next level (Vaughn et al., 2019). Combining FRSI-focused intervention programs including decoding and CSI-focused intervention programs might support generalizing skills. This is why, it is suggested as an efficient approach for students with RD (Gersten et al., 2009). Through this process, the low generalization skills of students with RD might be supported with MI intervention programs.

Participant characteristics

According to the results of this research, the effects of instructional intervention programs on the reading abilities of students with RD didn't vary according to the participant students' characteristics. It is determined that the effects of instructional intervention programs on the reading abilities of students with LD and RD (ES=.69) are medium-level while they are low-level for students at-risk RD (ES=.34). This finding indicates that instructional interventions development the reading abilities of students with RD. The measurements are based on standard tests, which can be the reason why instructional intervention programs have low-impact levels on the reading abilities of students at-risk RD. On the other hand, low cut-off scores in standard tests can be one of the reasons for this result.

Grade level

In this research, instructional intervention programs on the reading abilities of individuals with RD didn't meaningfully vary according to the grade level of participant students. It is observed that the instructional intervention programs used for K8 (ES=.39) level students created a lower impact when compared to K12 (ES=.55). This finding can be related to the fact that basic education students' cognitive skills have been developing in this period. Based on this finding, it can be said that preparing instructional intervention programs according to their grade and age is important. When we look at the effects of instructional intervention programs according to the grade of students with RD, different findings are obtained in different studies. Instructional interventions focusing on CSI intervention programs

(e.g. finding the main idea, summarizing) are more commonly used in the reading abilities of students with RD at high grades. It is also found that this use contributed to improving their reading abilities (Solis et al., 2012). On the other hand, there are studies in the literature indicating that instructional intervention programs at lower grades are more effective when compared to practices at higher grades (Gersten et al., 2020). Therefore, further research focusing on the effects of instructional interventions on the reading abilities of individuals with RD is warranted (Al Otaiba et al., 2022).

Publication year

This research, it is identified that the effects of instructional interventions on the reading abilities of individuals with RD decreased according to the period of the program. New studies created significantly smaller impact sizes when compared to the older ones. Standardized measurements are used in more current studies; this might be an important factor in the decrease of impact size values according to years (Scammacca et al., 2015). It is reported that the use of standardized measurements in instructional intervention programs created a smaller impact size (Willingham, 2007). Based on this finding, it can be said that it is necessary to make second order meta-analysis studies which include current research about the efficiency of instructional interventions on the reading abilities of individuals with RD.

Another reason behind the decrease in impact size values in terms of the variable of the year might be the different features of instructional intervention programs included in the second order meta-analysis (intervention period, intensity, application type, etc.). The period of intervention, the intensity of it, application of the intervention to individuals or groups might be the reasons behind different intervention impact sizes. In this respect, presenting and organizing the characteristics of instructional interventions in studies included in analyses might lead to a better, more reliable interpretation of impact size values. One other reason for the decrease in these values is the characteristics of participant groups to which the instructional intervention programs are applied. In recent years, diagnostic criteria are developed by researchers and different countries to determine students with LD and RD. Students with RD are better determined through these carefully evaluated criteria.

Meta-analysis quality

In this study, it was found that primary meta-analysis studies with high-quality levels yielded lower impact sizes. It is also observed that the primary meta-analysis research that does not have publication bias produced a higher impact size. These two findings might result from the fact that researchers with low-quality scores did not present and publication bias report. Considering this finding, it is important to emphasize the implementation of enhanced procedures in conducting high-quality meta-analysis research (Higgins, et al., 2019). On the other hand, it is necessary to evaluate the quality of research studies that include meta-analysis research (Kung et al., 2010).

Conclusions

In this research, it is determined that instructional interventions have a medium-level impact on the reading abilities of individuals with RD. There are differences in the level of these impacts according to the preferred intervention type. It is observed that CSI intervention programs are more efficient than FRSI intervention programs. On the other hand, it is found that MI interventions have a low-level impact on the reading abilities of individuals with RD.

The effect of instructional interventions on the reading abilities of individuals with RD didn't vary according to participant characteristics. It is seen that instructional intervention programs are more effective on students with LD, while they have a lower impact on students at-risk RD. Similarly, no variation in the efficiency of instructional intervention programs is observed in terms of the grade level of individuals with RD. It is found that the effects of instructional intervention programs at the K8 level are lower.

The effects of instructional intervention programs on the reading abilities of students with RD didn't vary according to the variable of quality level. It is concluded that the primary meta-analysis studies with high-quality levels produce a lower impact size. The effects of instructional intervention programs on the reading abilities of students with RD varied according to the publication bias report. Primary meta-analysis studies with no publication bias report produce a higher impact size according to this research.

Limitations of the research

The findings of the research are interpreted by considering a few limitations. There are some limitations in the study resulting from the method. Firstly, the findings presented in this study are limited to the instructional interventions intended to support the reading abilities of individuals with RD. Secondly, some of the studies included in the analysis couldn't yield sufficient detail for encoding the included moderator variables. For instance, as the sampling group has a heterogeneous distribution, encoding the studies was difficult. There is not a single, clear definitive criterion about the characteristics of students with RD. The reason for this confusion might be the fact that these students have different characteristics. On the other hand, the variability in intervention programs and participant characteristics made it difficult to code the interventions.

Implications and future directions for research

It was concluded that CSI and FRSI intervention programs are effective on the reading skills of students with reading difficulties. In-service training can be given to teachers on the preparation and implementation of rich learning environments that take these intervention programmes into consideration. In addition, sample lesson plans about these intervention programs can be prepared and made available to teachers.

Results obtained from this research indicate that instructional interventions had a medium-level impact on the reading abilities of individuals with RD. CSI and FRSI intervention programs were efficient in terms of supporting the reading abilities of individuals with RD. However, more detailed analyses are necessary to determine which of these two intervention types can be preferred. On the other hand, experimental studies can be carried out to analyze multi-component instructional intervention programs' effects (a combination of FRSI and CSI-focused intervention programs). MI intervention programs promise hope in terms of supporting and developing the generalization skills of individuals with RD.

In this research, it is seen that instructional intervention programs didn't cause a change in the reading abilities of individuals with RD according to the participant characteristics. It is necessary to make more experimental studies to determine if instructional interventions cause meaningful differences in terms of the characteristics of participant students. It can also be beneficial to carry out primary meta-analysis studies that test the effects of instructional intervention programs on the reading abilities of students with RD who are determined with

standardized tests.

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Note: Studies involved in second order meta-analysis are marked with *