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A meta-analysis of the effects of academic interventions on academic achievement and academic anxiety outcomes in elementary school children

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Abstract

Research has shown that academic anxiety can affect academic performance and emotional well-being. Despite previous research emphasizing the importance of understanding academic anxiety and indicating a strong association between academic performance and academic anxiety, no systematic reviews or meta-analyses have examined the effects of academic interventions on academic and anxiety outcomes. This article reports on a meta-analysis of studies examining academic interventions conducted with elementary students (kindergarten to Grade 6), in which both academic achievement and academic anxiety outcomes were reported. The systematic search yielded 13 studies comprising 1,545 participants and revealed statistically significant differences favoring academic treatments over the control for academic achievement outcomes ($g = 0.63$, $k = 11$) but no statistically significant benefits for academic anxiety outcomes ($g = -0.06$, $k = 11$). The authors caution against drawing strong conclusions due to the heterogeneity in effects and the small number of studies in the extant literature.

Keywords

academic intervention; school-based; academic anxiety; academic outcomes; anxiety outcomes; meta-analysis

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Anxiety is one of the most common childhood mental health concerns (Ghandour et al., 2019; Merikangas et al., 2010), with onset of symptoms beginning early in youth (Lavigne et al., 2009). Anxiety symptoms can include avoidance behaviors (e.g., social withdrawal,

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task avoidance), somatic behaviors (e.g., headache, stomach aches), or physiological arousal (e.g., perspiration, rapid breathing). Not only can anxiety symptoms affect day-to-day life, but individuals with anxiety are also at increased risk for continued anxiety, depression, illicit drug use, and educational underachievement (Woodward & Fergusson, 2001). In addition to children who experience clinical levels of anxiety, many children present with heightened yet subclinical levels of anxiety that can still impair functioning (Ohannessian et al., 1999).

Anxiety is often categorized as either trait anxiety (characterized by stable levels of arousal across situations) or state anxiety (distinguished by variable levels of arousal that occur in response to specific situations; Owens et al., 2008). Academic anxiety is considered a state-specific type of anxiety in which students experience cognitive, physiological, and behavioral responses to educational contexts (Cassady, 2010). Academic anxiety can occur in specific contexts (e.g., test taking, public speaking) and within specific content areas (e.g., math, reading). Special populations in academic settings (e.g., students with learning disabilities) can also experience academic anxiety (Cassady, 2010).

Recent research has shown that many forms of academic anxiety are considered multidimensional. For instance, math anxiety has been found to have affective (emotional) and cognitive (worry) dimensions, and the affective dimension has been found to be more strongly related to negative achievement (Ho et al., 2000). However, for test anxiety, the cognitive worry dimension has been found to be more strongly correlated to negative achievement (Morris et al., 1981). Symptoms of academic anxiety include concentration and attention problems, oversensitivity, withdrawal, difficulties with problem-solving, emotional dysregulation, excessive worry, and task avoidance (Huberty, 2009; Killu et al., 2016). These symptoms can interfere with a student's ability to be successful during academic tasks (Bryan et al., 2004; Ohannessian et al., 1999) and can worsen over time (Gierl & Bisanz, 1995; Ohannessian et al., 1999).

Previous research consistently shows that academic performance is negatively associated with academic anxiety (Hembree, 1988; Ma, 1999; Namkung et al., 2019; von der Embse et al., 2018). For instance, Ma (1999) examined 26 studies and found a negative correlation of .27 between mathematics anxiety and achievement in mathematics. These findings were consistent across grade (4–12), gender, year the studies were published, and instrument used to measure anxiety. Nelson and Harwood's (2011) meta-analysis of 3,336 students with learning disabilities found these students had significantly higher levels of anxiety than their peers. Similarly, a meta-analysis by Francis et al. (2019) identified 34 studies comprising 16,275 participants and found that poor readers were statistically significantly at more risk for experiencing anxiety than typical readers. Furthermore, not only is academic performance negatively related to academic anxiety, but children with elevated anxiety also frequently present comorbid emotional and social difficulties, such as low self-concept and school avoidance (Grills & Ollendick, 2002; Kellam et al., 1994).

Given the prevalence of childhood anxiety (Merikangas et al., 2010) and adverse outcomes associated with academic anxiety, previous researchers have sought to understand the causal link between academic underperformance and anxiety (Hembree, 1988; Ma &

Xu, 2004; Namkung et al., 2019). Better understanding this relation has the potential to inform future intervention development. For instance, if academic anxiety is primarily a product of academic underperformance, it follows that interventions should primarily target improvements in academics. Conversely, if academic anxiety produces academic underperformance or there is a bidirectional relation between these constructs, interventions may need to focus directly on improvements in academic performance and academic anxiety.

Previous research examining this relation has typically focused on correlational data (e.g., Ma, 1999; von der Embse et al., 2018). For example, Ma (1999) examined the relationship between achievement in math and anxiety toward math. The current meta-analysis builds upon our understanding and fills a gap in the previous concurrent and longitudinal correlational research by examining experimental research to determine the effects of academic interventions on academic achievement and academic anxiety outcomes and yield a better understanding of the relation between anxiety and academic outcomes.

The Causal Relation Between Academic Anxiety and Achievement

Many competing models explain the relation between achievement and anxiety. We highlight three models to illustrate the complexity of this relation and to provide a basis for interpreting the evidence from this synthesis.

Model 1: Poor Achievement Leads to Higher Anxiety

One explanation for how poor achievement is related to anxiety is that children develop symptoms of anxiety in response to academic failure at school (Grills-Taquechel et al., 2012). Repeated academic failure, along with social or environmental cues about failure, could lead students to perceive that their skills need improvement, fueling a more anxious or fearful approach to the task (Beilock & Willingham, 2014). Furthermore, anxiety can be social in nature, and failure in school might lead some students to worry about what teachers and peers think of them (Kellam et al., 1994). Self-worth theories suggest that students work to protect perceptions of their ability. Experiencing failure after effort could threaten one’s self-worth, which could trigger test anxiety (Covington, 1984).

In a study where low-achieving first-grade students were provided a reading intervention, achievement improved and internalizing symptoms of depression decreased (Kellam et al., 1994). This finding suggests that targeting achievement in early elementary school students could affect internal symptoms, including, perhaps, anxiety (Grills-Taquechel et al., 2012). Ma and Xu (2004) conducted a longitudinal study on students in Grades 7–12 and found that math achievement was negatively associated with later math anxiety, but that math anxiety did not lead to later low math achievement. Furthermore, and in support of this model, one might hypothesize that students with learning difficulties have more anxiety than their peers, which has been the case, but causality remains unclear (Francis et al., 2019; Nelson & Harwood, 2011).

Model 2: Anxiety Negatively Influences Achievement

An alternative hypothesis is that anxiety negatively influences achievement. This hypothesis is sometimes referred to as the cognitive interference theory, where students are preoccupied, use limited working memory, and their attention is not focused on instruction (Carey et al., 2016; Peng & Fuchs, 2016). Anxiety might hinder performance for a number of reasons, including (a) physical symptoms of anxiety (e.g., stomach aches) could lead to students staying home from school (Bernstein & Shaw, 1997), (b) students experiencing anxiety (e.g., perceived threatening situations and stimuli) could miss information through distraction (e.g., worrying) or compromised cognitive resources (e.g., disturbance of working memory, recall, or attention; Killu et al., 2016; Ramirez et al., 2013; Woodward & Fergusson, 2001), and (c) avoiding or escaping anxious feelings might cause students to continuously miss learning opportunities (Ashcraft, 2002; Grills-Taquechel et al., 2013).

In a meta-analysis examining the effects of school-based anxiety interventions (Tutsch et al., 2019), four studies were identified, and none examined the effects on academic achievement outcomes. Although the studies found that school-based anxiety interventions were associated with reductions in anxiety, the authors could not determine the extent to which improving anxiety outcomes led to improvement in achievement, as may be expected if Model 2 is valid.

However, some research suggests that reducing test anxiety improves academic performance. A systematic review by von der Embse, Barterian, and Segool (2013) examined the effects of interventions targeting reductions in test anxiety on test anxiety and academic performance. The findings demonstrated some test-anxiety interventions (e.g., behavioral, cognitive, cognitive-behavioral, academic skill building, biofeedback) reduced test anxiety and improved academic performance. This finding is consistent with that of Hembree (1988), who also found that reduction in test anxiety led to improved academic achievement.

Model 3: Bidirectional Relation Between Academic Anxiety and Academic Achievement

The final model proposed to explain the causal link between anxiety and academic performance posits that the two constructs have a bidirectional relation. In this model, anxiety develops in students who experience learning difficulties, and this emotional distress leads to more severe forms of learning difficulties (Capin et al., 2021; Grills-Taquechel et al., 2012; Killu et al., 2016; Willcutt et al., 2013). Willcutt and colleagues (2013) found that students with comorbid reading and math disabilities were more impaired than students with a learning disability in only one area relative to both academic functioning and internalizing psychopathology. If academic performance and academic anxiety have a bidirectional relationship, this would lend credence to both Models 1 and 2. Namkung and colleagues (2019) conducted a meta-analysis and found similar strength of relation between math anxiety and performance when examining concurrent and longitudinal relations. This suggests math anxiety and performance may develop continuously and affect each other in a cycle. Namkung and colleagues concluded that future intervention studies should focus on remediating mathematics deficits and reducing math anxiety simultaneously, particularly for children in the elementary grades.

Another model related to the bidirectionality of this relationship is the self-regulation model of performance, which posits that students who develop expectancies of performance and perceive a discrepancy between their functioning and a goal engage in self-focused attention and worry that leads to further self-focused attention, which is detrimental to academic achievement (Rich & Woolever, 1988). The biopsychosocial model of test anxiety (Lowe et al., 2008) stresses the importance of considering social, cognitive, and physiological factors and how they interact to influence test anxiety (von der Embse, Kilgus, et al., 2013). The biopsychosocial model suggests that individual differences, including biological and psychological factors, interact with factors of the larger social context. In addition to considering the broader social context, this model posits that test performance influences anxiety and vice versa, which supports the bidirectional relation (Lowe et al., 2008).

The Present Study

The purpose of the present meta-analysis was to examine the extent to which academic interventions focused on knowledge building improve academic and academic anxiety outcomes. Previous models of the relation between academic performance and academic anxiety—namely, models indicating that poor performance leads to higher anxiety and bidirectional models—suggest that academic interventions that improve student learning may also positively influence academic anxiety outcomes. However, no meta-analysis to date has investigated the effects of school-based academic interventions on both academic achievement and academic anxiety. We focused on elementary students because previous research suggests that students begin to experience academic anxiety in the primary grades, thus underscoring the potential importance of early academic intervention (Ergene, 2003; Grills-Taquechel et al., 2012; Hembree, 1988; Namkung et al., 2019). Thus, we addressed the following primary research question: What are the effects of school-based academic interventions on academic anxiety and academic achievement outcomes in elementary school children? We hypothesized that the effects of academic interventions would be greater on academic achievement outcomes than anxiety outcomes, but that we might see small reductions in anxiety. These findings may help to better understand the causal nature between academic anxiety and performance. For instance, small yet statistically significant differences in academic anxiety that result from academic interventions would provide support for Model 1 (i.e., poor achievement leads to higher anxiety) and Model 3 (i.e., a bidirectional relation between academic anxiety and academic achievement.)

Method

Operational Definitions

This meta-analysis examined existing studies that evaluated the effects of academic interventions on academic achievement and academic anxiety outcomes. As such, articles were included in the meta-analysis if they examined an academic intervention as the independent variable and both academic achievement and academic anxiety as dependent variables. During the screening process we evaluated source articles against the operational definitions for the terms *academic interventions* and *academic anxiety*, as outlined below.

Academic Interventions—Similar to previous literature examining the effects of school-based academic interventions (e.g., Dietrichson et al., 2020), we defined academic interventions as instruction in an academic content area (e.g., computer-assisted instruction in math) with a primary aim to improve academic content knowledge. Put differently, the intervention had to consist of academic activities, with an explicit expectation in the study that the intervention would result in improved academic knowledge.

Generalized strategy instruction (e.g., time management, test-taking skills, mindset instruction, cognitive behavior therapy, relaxation techniques, stereotype threat education, cognition strategies, goal setting, learning strategies) was not considered to be an academic intervention on its own. However, if a study included an intervention with instruction aimed at improving content knowledge and embedded a generalized strategy, such as adding a meta-cognitive or a cognitive behavior therapy component, the study qualified for inclusion. See Figure 1 for further information on excluded studies.

Academic Anxiety—Due to the inconsistent application of the term "academic anxiety" along with a lack of research examining this anxiety dimension (Cassady et al., 2019), we operationalized academic anxiety as a broad construct and included both context-specific academic anxiety (e.g., test anxiety) and content-area-specific anxiety (e.g., math anxiety, writing anxiety, reading anxiety). This definition is consistent with Cassady and colleagues (2019), who considered academic anxiety to include anxieties "related to typical academic activities" (p. 3). The first or second author reviewed the anxiety measures to ensure that questions or items to be rated were specific to academic anxieties (e.g., "I feel tense and nervous when working with texts", "I avoid writing", "When the teacher says she will find out how much you have learned, does your heart begin to beat faster?"). Studies were excluded if they stated that they measured school anxiety but used a general anxiety measure and asked general anxiety questions (e.g., "I worry a lot of the time", "I am nervous", "Often, I feel sick to my stomach"). That is, outcome measures had to include items or questions specific to anxiety associated with school, learning, or academic performance. If the study itself did not provide information about the questions or items included in the anxiety measure, the first or second author sought to locate further information about the measure, met with the research team to discuss the measure, and reached a consensus about its inclusion. If it could not be determined that an anxiety-related measure was specific to academic anxiety and no other anxiety-related measures met criteria, the study was not included.

Inclusion and Exclusion Criteria

For the descriptive synthesis and quantitative meta-analysis, we included studies that met the following criteria:

- Published in a peer-reviewed journal or an unpublished dissertation printed in English through November 2019
- Employed an experimental or quasi-experimental design with a treatment and a comparison to determine the experimental effect

- Participants in elementary school (kindergarten through either fifth or sixth grade, depending on the school system; including both typical learners and learners with academic or emotional disabilities)
- Examined an academic intervention related to an academic skill or content area, instructional method, or instructional tool
- Assessed both academic achievement outcomes and academic anxiety outcomes

In addition to the above, the quantitative meta-analysis had one additional inclusion criteria:

- Studies had to include sufficient information to calculate effect size (i.e., means, standard deviations, and sample size; or *F* ratios, *t* statistics, ANCOVA statistics, or chi-square statistics when summary statistics were not provided.)

Search Procedures

This review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA; Liberati et al., 2009). To locate all relevant studies, published and unpublished studies were searched through November 2019. A start date was not specified in order to conduct a comprehensive review of the evidence base. Various techniques were used to locate relevant studies for the synthesis. First, the following electronic databases were searched: Education Source, ERIC, PsycINFO, CINAHL Plus, and MEDLINE. Search terms were organized by category, which included terms for location (*school* OR *classroom* OR *student* OR *teacher*), intervention and instruction (*intervention* OR *treatment* OR *program** OR *curricul**), anxiety (*anxi**), academic achievement outcomes [((*reading* OR *math** OR *academic*) n2 (*achievement* OR *outcomes* OR *performance* OR *success* OR *skills*))], and experimental study or design (*study* OR *experiment** OR *"clinical trial"* OR *randomized* OR "*randomly assigned"* OR *"assigned at random"* OR *"quasi-experimental"*).

The database search returned 6,964 records. After duplicates were removed, 4,935 records required abstract and title screening. The first two authors independently reviewed all the abstracts to determine whether the full text of the study should be further reviewed for inclusion in the systematic review. The authors sorted the abstracts with 95% reliability and discussed all discrepancies to reach consensus. Of those, 4,544 records were excluded, leaving 391 articles to be assessed for eligibility using the full text. Of those, 378 articles were excluded for the following reasons: not available in English, no academic or academic anxiety outcomes, did not evaluate an academic intervention, study design, age of the participants (not in elementary school), publication type, or the setting was not in a school. See Figure 1 for a PRISMA diagram detailing the search process.

Following the electronic database search, a hand search over the previous 2 years of publication of the following journals was conducted (from November 2017 to November 2019): *Educational & Child Psychology*, *Metacognition and Learning*, *The Journal of Clinical Child and Adolescent Psychology*, *Evidence-Based Practice in Child and Adolescent Mental Health*, and *American Academy of Child & Adolescent Psychiatry*. These journals were selected for two reasons: Either qualifying studies had been published in the journal or the journal contained relevant empirical content related to mental health and academic anxiety intervention research. Furthermore, a comprehensive hand search of

Anxiety, Stress, & Coping was conducted from its inception (1988) to present (November 2019) because relevant empirical research from 1988 had been identified (Kalechstein et al., 1988). No additional articles were identified in the hand search. Lastly, a forward and backward ancestral search of included studies resulted in a full-text screening of 28 additional articles, of which one qualified. A total of 13 experimental studies published in peer-reviewed journals or doctoral dissertations met inclusion criteria.

Data Extraction

We coded studies that met inclusion criteria using a protocol (Vaughn et al., 2014) developed and used in previous research (Wanzek et al., 2018) to extract information from academic intervention studies. The protocol aligns with study features detailed in the What Works Clearinghouse Design and Implementation Assessment Device (Valentine & Cooper, 2008). We extracted the following from each article: (a) study characteristics (publication year, study design, research quality), (b) student participant demographics (e.g., age, grade, gender, risk factors), (c) intervention characteristics (e.g., interventionist, group size, length of intervention, content area), (d) measure details (e.g., name, content area, standardized vs. unstandardized), and (e) overall findings and effect size. The variables that we extracted were guided by previous research studying academic interventions and academic anxiety (Ma, 1999; Namkung et al., 2019) and are commonly recommended for reviews (Lipsey, 2019). We extracted study characteristics, student participant demographics, and intervention characteristics to describe our source studies. Previous research (Ma, 1999) found that the relationship between anxiety and achievement differed, depending on the types of instruments used, with standardized measures reporting significantly weaker relation. Based on this potentially important finding, we had hoped to conduct a moderator analysis on type of measure (standardized vs. not standardized). However, a moderator analysis was not possible as there was an inadequate number of “effects.”

We examined descriptors of interest, as is common to meta-analytic reviews, to help with interpretation of effect sizes, including study conditions, participant details, and study quality (Lipsey, 2019). For study conditions, coders extracted details about the independent variable (the academic intervention) and also reported information about the comparison group, as described in the study. As is recommended (Wilson, 2019) and commonly reported in reviews, we described the study descriptors using the language of the source articles (see Table 2 for study condition examples). Furthermore, we coded each study for participant risk type as described in the study. If students in the study were described as struggling learners or at academic risk, they were reported as academic risk. If students were described as typical learners with no academic or emotional disabilities, students were described as no risk. If students were identified with high academic ability, they were reported as gifted. Studies that included students with mixed abilities were reported as such. We also reported whether students were English language learners.

We coded each study for quality based on four indicators: research design, sample size, attrition, and intervention contaminants. We used What Works Clearinghouse standards (IES, 2021b) for research design quality and previous research focused on reading intervention study quality (Austin et al., 2019) to identify these key indicators. A study was rated as high quality if group membership was determined through a random process, it had a sufficiently large sample of greater than or equal to 20 participants, it had low attrition (we classified attrition as low or high based on the What Works Clearinghouse standards (IES, 2021b), and there was no evidence of other intervention contaminants. A study was rated as medium quality if group membership was not determined through a random process but equivalence was established at baseline, and there were sufficient sample size (> 20), low attrition, and no intervention contaminants. A study was also rated medium quality if group membership was determined through a random process but attrition was not reported or there were concerning intervention contaminants (e.g., events that could have interfered with our ability to make a causal inference about the intervention). A study was rated as low quality if group membership was not determined through a random process and equivalence was not established at baseline or if a study reported high attrition according to What Works Clearinghouse standards (IES, 2021b) or insufficient sample size (< 20).

The gold-standard method of coder training (Gwet, 2001) was used to establish interrater reliability prior to coding. The first and second author provided a 3-hour training on how to use the code sheet using a related study. Next, coders independently coded the first study. Then, all coders reviewed each item on the code sheet and clarified any discrepancies. The team of four coders included one Ph.D.-level researcher and three Ph.D. graduate research assistants studying learning disabilities and behavior disorder intervention research. Coders achieved interrater reliability of 94.21%, 96.32%, and 93.68%, as determined by the number of items in agreement divided by the total number of items. After establishing initial reliability, each study was independently double coded by the first or second author and a trained coder, resulting in an average reliability of 95.88% on the source studies. The coders met to review each code sheet and to identify and resolve any discrepancies. When the authors were unable to resolve a specific code, the first and second author met to come to a consensus.

Statistical Analysis: Effect Size Calculation

Standardized mean differences (SMD) were calculated when means, standard deviations, and sample sizes were included in the study using Equation 1:

$$SMD = \frac{\bar{Y}_T - \overline{Y_C}}{s_p} \tag{1}$$

where $\bar{Y}_T - \overline{Y_C}$ is the difference between the mean for the treatment group and mean for the control group. The following is the formula for the pooled standard deviation, s_p:

$$S_p = \sqrt{\frac{(n_T - 1)s_T^2 + (n_C - 1)s_C^2}{n_T + n_C{}^{-2}}} \tag{2}$$

where S_T^2 and S_C^2 are the variances on the dependent variable (academic anxiety or academic achievement outcome) and n_T is the number of students in the treatment group and n_c is the number of students in the control group. We computed the effect sizes from *F*, ANCOVA, or *t* statistics when summary statistics were not provided (Lipsey & Wilson, 2001; Borenstein, 2009). Since Schweiker-Marra and Marra (2000) reported an ANCOVA without reporting an R2 value, we imputed 0 for R2 as is suggested by the What Works Clearinghouse Procedures Handbook (IES, 2021a) to protect against type I error. Primary studies were excluded from the quantitative meta-analysis when they did not report sufficient information to calculate an effect size; two studies were not included in the meta-analysis but were described descriptively due to the inability to determine sample size for the treatment groups of interest. An effect size was calculated for each comparison made that fit our inclusion criteria. If a study also disaggregated the results based on sample characteristics, we included only the effect size that described the entire sample. Then we converted all the effect sizes to Hedges' *g* to account for positive bias in small samples by multiplying each effect size by the following bias-correction formula (Hedges, 1981):

$$\omega(df) = \left[1 - \frac{3}{(4df - 1)}\right] \quad (3)$$

where $df = n_T + n_C - 2$.

We also computed the variances for the Hedges' *g* effect size using the following formula, which we corrected for small-sample bias:

$$\mathrm{v}_g = [\omega(df)]^2\left\{\left[\frac{\mathrm{n_T} + \mathrm{n_C}}{\mathrm{n_T}\mathrm{n_C}}\right] + \left[\frac{\mathrm{g}^2}{2(\mathrm{n_T} + \mathrm{n_C})}\right]\right\} \quad (4)$$

To account for studies that randomly assigned the treatment to clusters of students (e.g., schools or classrooms), we adjusted the effect sizes and the variances to correct for clustering. If the cluster structure is ignored, the standard errors are underestimated for the effect sizes. These methods were first introduced in Hedges and Hedberg (2007), but the equations were later corrected (What Works Clearinghouse, 2020; Taylor et al., 2021). The cluster-corrected Hedges' *g* is as follows:

$$\mathrm{g_{corr}} = \frac{\omega(df)\left(\bar{Y}_T - \bar{T}_C\right)}{s_p}\sqrt{1 - \frac{2(n-1)\rho}{n_T + n_C - 2}} \quad (5)$$

where ρ is the intraclass correlation coefficient and n is the average number of individuals per cluster. For the bias-correction term $\omega(df)$, the df is the degrees of freedom for cluster-level assignment studies, calculated using the following equation:

$$df = \frac{\left[(N-2) - 2\left(\frac{N}{M} - 1\right)\rho\right]^2}{(N-2)(1-\rho)^2 + \frac{N}{M}\left(N - 2\left(\frac{N}{M}\right)\right)\rho^2 + 2\left(N - 2\left(\frac{N}{M}\right)\right)\rho(1-\rho)} \quad (6)$$

where $N = n_T + n_C$ and M is the total number of clusters in the intervention. The equation for the cluster-corrected variance is as follows:

$$v_g = [\omega(df)]^2\left(\left[\frac{N}{n_T n_C}\right](1 + (n-1)\rho) + g^2\frac{(N-2)(1-\rho)^2 + n(N-2n)\rho^2 + 2(N-2n)\rho(1-\rho)}{2[(N-2)-2(n-1)\rho]^2}\right) \quad (7)$$

We corrected the effect sizes for Beard (2003), Lysenko et al. (2016), Mevarech (1985), and Schweiker-Marra and Marra (2000). Because the primary studies did not provide enough information to calculate an intraclass correlation coefficient (ICC), we imputed ICC estimates for the mathematics outcomes from the Online Intraclass Correlation Database (Hedges & Hedberg, 2007, 2014), which provides ICCs from national studies. For the anxiety outcomes, we used an ICC of 0.1 based on the recommendation from the What Works Clearinghouse Procedures Handbook (IES, 2021a) as default when study-ICC values are not available for nonachievement outcomes.

Researchers used the *metaphor* package (Viechtbauer, 2010) or their own functions in R to calculate effect sizes and run analyses. Using Tukey's definition for outliers where values more than 1.4 times the interquartile range from the quartiles, we detected no outliers among either type of outcome. Dependence among effect sizes arose because there were either multiple measures of the outcome construct using the same sample or multiple comparisons were made with different treatment groups to the same control condition in a few studies. To account for dependency within studies and to model the two outcome types, we used a modified subgroup correlated effects (SCE) model (Pustejovsky & Tipton, 2020) where we modeled the academic anxiety and academic achievement outcomes as correlated using *metafor* and *clubSandwich* R package with small-sample correction adjustment to the residuals and degrees of freedom (Pustejovsky, 2019; Tipton, 2015; Viechtbauer, 2010). Typically, this model assumes effect sizes from academic anxiety and academic achievement outcomes are independent and allows us to synthesize effect sizes across the two constructs while accounting for dependency within studies. However, one variation of this model is to model the outcome types as correlated, which more accurately reflects our hypothesis. Because the SCE model with outcome types as independent is a simpler model, we decided to include it as a sensitivity analysis. We assumed a correlation of .80 between effect sizes for the covariance matrix, but robust variance estimator is agnostic to correlation misspecification. We also corrected the standard errors for small sample size using the cluster robust variance estimator and *clubSandwich* R package (Pustejovsky, 2019).

We evaluated potential publication bias through Egger's regression accounting for dependent effect sizes (Egger et al., 1997; Rodgers & Pustejovsky, 2021). Because there are currently no methods to evaluate publication bias using the SCE model, we examined the academic and academic anxiety outcomes separately.

Results

Our results are twofold. First, we describe the 13 studies identified in our systematic search. Then, we present our meta-analysis of 11 studies where 34 effect sizes could be calculated, of which 17 were for academic achievement outcomes and 17 were for academic anxiety outcomes. Table 1 provides the study characteristics for the 13 studies identified in this synthesis and summarizes the (a) publication year, (b) study design, (c) academic and anxiety measure type, (d) content area, (e) instructional group size, and (f) interventionist. Table 2 includes (a) study content area and description of conditions, (b) student characteristics, and (c) study characteristics for each of the 13 included studies. Table 3 includes (a) academic achievement measure(s) used and measure type, (b) academic achievement outcome effect size(s), (c) academic anxiety type, (d) academic anxiety measure(s) used and measure type, and (e) academic anxiety outcome effect size(s). Figure 2 shows the strength of the standardized mean difference between treatment and comparison on academic achievement outcomes, and Figure 3 shows the strength of the standardized mean difference between treatment and comparison on academic anxiety outcomes.

Study Features

Population and Setting—Collectively, 13 studies provided academic interventions to a total of 1,545 participants in nine countries across three continents. Four studies took place in North America (Beard, 2003; Lysenko et al., 2016; Ramirez et al., 2009; Schweiker-Marra & Marra, 2000), four in Asia (Barner et al., 2016; Kramarski et al., 2009; Mevarech, 1985; Mevarech & Ben-Artzi, 1987), four in Europe (Collingwood & Dewey, 2018; Jansen et al., 2013; Obergriesser & Stoeger, 2015; Tok, 2013), and one in Oceania (Chalip & Chalip, 1978). Participants ranged from first to sixth grades (in some countries, sixth grade is still elementary school), and sample sizes ranged from 24 to 245 participants ($M = 119$).

Of the 13 studies, 6 reported a gender breakdown of participants. The percentage of males ranged from 47% to 62% ($M = 52.32\%$), and three studies reported almost equal males and females (Beard, 2003; Chalip & Chalip, 1978; Kramarski et al., 2009). Six of the studies reported socioeconomic backgrounds of the participants. Of those, five reported students from economically disadvantaged households, ranging from 46% eligible for free or reduced-price lunch to 93% from economically disadvantaged households (Barner et al., 2016; Beard, 2003; Mevarech, 1985; Ramirez et al., 2009; Schweiker-Marra & Marra, 2000). One study reported students from mixed economic background (Collingwood & Dewey, 2018). Six studies did not report students to be at any academic risk (Barner et al., 2016; Collingwood & Dewey, 2018; Lysenko et al., 2016; Mevarech, 1985; Mevarech & Ben-Artzi, 1987; Tok, 2013). Four studies included a mix of academic ability (Beard, 2003; Chalip & Chalip, 1978; Jansen et al., 2013; Kramarski et al., 2009). Two studies included students at risk of academic failure (Ramirez et al., 2009; Schweiker-Marra & Marra, 2000). Finally, one study included students identified as gifted underachievers (Obergriesser & Stoeger, 2015).

Intervention Foci—Of the 13 studies, 9 focused on math (Barner et al., 2016; Beard, 2003; Collingwood & Dewey, 2018; Jansen et al., 2013; Kramarski et al., 2009; Lysenko et al., 2016; Mevarech, 1985; Mevarech & Ben-Artzi, 1987; Tok, 2013), three focused on literacy (Chalip & Chalip, 1978; Ramirez et al., 2009; Schweiker-Marra & Marra, 2000), and one focused on science (Obergriesser & Stoeger, 2015; see Table 2). In 11 of the 13 studies, the purpose was examining the effects of an academic intervention, no anxiety management component was embedded within the intervention, and improved academic and academic anxiety outcomes were hypothesized. Four of the studies integrated meta-cognitive strategies, including thinking sheets to help solve math problems (Collingwood & Dewey, 2018), self-regulated learning to enhance problem solving and reduce anxiety (Kramarski et al., 2009), self-assessment and monitoring in combination with text-reduction strategies (Obergriesser & Stoeger, 2015), and a "know-want-learn" strategy to help students understand how they learn best (Tok, 2013).

In two studies, the authors tested an academic intervention that included anxiety-management practices. Collingwood and Dewey (2018) integrated math problem solving with self-regulated learning, mindful breathing, modeling and peer talk, jokes and comic strips, and self-coping statements to improve academic achievement and academic anxiety outcomes. Ramirez et al. (2009) used therapists with counseling expertise as the interventionists to deliver Cuento Therapy, an intervention where Spanish tales were read in English and in Spanish with illustrations and discussions included using question stems, role play, and circle time before and after each session. They used an aspect of the intervention (i.e., circle time) to allow students to interact with the therapist to target students' self-esteem. These two studies are in contrast to the other studies that tested the effect of interventions that taught academic practices, without any anxiety-management component, on academic and anxiety outcomes.

Intervention Characteristics—All interventions occurred during regular school hours, except for one remedial summer school program (Ramirez et al., 2009). Eight interventions were led by teachers (Chalip & Chalip, 1978; Kramarski et al., 2009; Lysenko et al., 2016; Mevarech, 1985; Mevarech & Ben-Artzi, 1987; Obergriesser & Stoeger, 2015; Schweiker-Marra & Marra, 2000; Tok, 2013), one was led by a researcher (Beard, 2003), one was led by a trained counselor and teacher (Ramirez et al., 2009), one was led by a teaching assistant (Collingwood & Dewey, 2018), and one was computer based (Jansen et al., 2013). The group sizes for the implemented interventions were not reported for six studies. Of the studies that reported group size, group sizes ranged from individual interventions to full-class interventions. The length of the interventions ranged from 3 hours total to 3 hours per week for 3 years (see Table 2).

Measures

Academic Achievement Measures—Sixteen different academic achievement measures were used across all studies. Seven of the measures were standardized (see Table 3); otherwise, the measures were non-standardized and included a teacher-developed measure (Chalip & Chalip, 1978), researcher-developed measures (Barner et al., 2016; Tok, 2013), an independent instrument (Jansen et al., 2013), a statewide achievement test (Schweiker-Marra & Marra, 2000), or not specified (Kramarski et al., 2009; Obergriesser & Stoeger, 2015).

Academic Anxiety Measures—Fifteen self-report measures of academic anxiety were reported across all 13 studies. Eight of the studies included math anxiety measures with items specific to (a) cognition, common worries, frustration, and confusion; (b) somatic bodily reactions; and/or (c) attitudinal indicators (Barner et al., 2016; Beard, 2003; Collingwood & Dewey, 2018; Jansen et al., 2013; Kramarski et al., 2009; Mevarech, 1985;

Mevarech & Ben-Artzi, 1987; Tok, 2013). Two studies focused on test anxiety measures (Chalip & Chalip, 1978; Ramirez et al., 2009) and two addressed general emotions about academic achievement (Lysenko et al., 2016; Obergriesser & Stoeger, 2015). Lastly, one study used a writing apprehension scale (Schweiker-Marra & Marra, 2000). Nine of the measures were standardized (see Table 3). When a standardized test was modified, we classified it at unstandardized.

Meta-Analytic Findings

Effects of Academic Interventions on Academic Achievement Outcomes— Effect sizes ($n = 17$) were calculated for 11 studies, as two of the studies could not be included in the analysis due to insufficient information (Kramarski et al., 2009; Mevarech & Ben-Artzi, 1987). For academic achievement outcomes, statistically significant differences favored the group receiving the academic intervention over the control across the 11 studies $g = 0.63$ ($SE = 0.19$, $t(9.25) = 3.26$, $p < .01$) with 95% CI [0.20, 1.07]. The heterogeneity index I^2 was 83.58% (where $\tau^2 = 0.29$), which indicates that there was substantial heterogeneity between studies and that we were not estimating the same underlying population value for the anxiety outcomes. This suggests that it would be desirable to explore systematic differences through moderator analysis. Unfortunately, there was an inadequate number of studies and effects to consider a moderator analysis. The results of the SCE model with independent outcome types resulted in the same conclusions ($g = 0.62$ [$SE = 0.19$, $t(9.23) = 3.23$, $p < .01$] with 95% CI [0.19, 1.06]).

A statistically significant effect was found in six of the studies, favoring the treatment group for at least one of the academic measures (see Figure 2). Of these, effect sizes calculated using Hedges' g ranged from 0.37 to 1.83. Statistically significant effects were found for math arithmetic and calculations (Barner et al., 2016; Collingwood & Dewey, 2018; Tok, 2013), noun and verb identification (Chalip & Chalip, 1978), identification of main ideas in text (Obergriesser & Stoeger, 2015), and writing performance (Schweiker-Marra & Marra, 2000).

Effects of Academic Interventions on Academic Anxiety Outcomes—A meta-analysis was conducted using the SCE model with correlated outcome types for studies ($k = 11$) reporting sufficient information, and effect sizes ($n = 17$) were calculated as Hedges' g. The overall pooled structure academic anxiety effect size estimate was $g = -0.06$ ($SE = 0.07$, $t(5.18) = -0.81$, $p = .45$) with 95% CI [−0.24, 0.13]. For the academic anxiety effects, the between-study heterogeneity index I^2 was 6.49% (where $\tau^2 = 0.004$), which suggests that the observed variability due to systematic between-study differences was small. For the sensitivity analysis, the SCE model with independent outcome types had an overall pooled structure academic anxiety effect size of $g = -0.03$ ($SE = 0.07$, $t(4.85) = -0.49$, $p = .65$) with 95% CI [−0.21, 0.15].

Across all studies, the effect size of anxiety measures ranged from −.84 to .45. But this range is not meaningful because most of the confidence intervals were wide and all contained zero, limiting our interpretation of the true magnitude and direction of the effect. In essence, this finding shows that the academic interventions had no practically important effect on academic anxiety outcomes.

Publication Bias

We evaluated the possibility of publication bias using Egger's regression with robust variance estimator. We found that Egger's regression coefficient was not significant for either academic achievement outcomes ($b = 1.78$, $SE = 0.72$, 95% CI [−0.04, 3.60], $t(5.31) = 2.47$, $p = .05$) or anxiety outcomes ($b = -0.91$, $SE = 0.64$, 95% CI [−2.49, .67], $t(5.69) = -1.42$, $p = .21$), suggesting that there was no funnel plot asymmetry. Thus, we report no evidence of publication bias.

Discussion

Research has found a negative association between academic achievement and academic anxiety (Ma, 1999; Namkung et al., 2019; von der Embse et al., 2018). Considering that academic anxiety is present in elementary school children (e.g., math anxiety found as early as first grade; Ramirez et al., 2013), we sought to understand the effects of academic interventions on academic anxiety and academic achievement outcomes in elementary-age students using meta-analytic approaches.

As hypothesized, the results of this meta-analysis show that academic interventions have a significant effect ($g = .63$; $p < .01$) on academic achievement outcomes. These results are consistent with previous research that has found generally positive results of school-based interventions on academic achievement outcomes (Dietrichson et al., 2020). In contrast, the results of this meta-analysis show that academic interventions do not have a significant effect ($g = -0.06$; $p = .45$; negative meaning that anxiety symptoms were reduced) on academic anxiety outcomes. These results suggest that academic interventions may not be associated with decreased academic anxiety symptoms, at least when applied in isolation. One of the source articles (i.e., Chalip & Chalip, 1978) suggested that the failure to show any effect of academic interventions on academic anxiety outcomes might indicate that academic interventions may need to be combined with anxiety-management practices. This interpretation is consistent with other research recommending that academic anxiety be considered within the context of academic interventions as a way to better tailor supports (Fletcher & Grigorenko, 2017; Francis et al., 2019; Grills et al., 2014; Namkung et al., 2019). This is also consistent with research supporting the synergistic effects of combining interventions to improve academic outcomes (Vansteenkiste et al., 2004).

In our corpus of studies, five used an integrated intervention approach. Two of the studies in our review incorporated an anxiety-management component. Collingwood and Dewey (2018) found small statistically significant differences favoring the group receiving the integrated academic intervention over the control group ($g = 0.37$) for academic achievement outcomes. They further reported no statistically significant difference in math anxiety outcomes between the experiment and control groups. Collingwood and Dewey used an integrated intervention for a total of 9 hr. This was a multicomponent intervention, which complicates findings because it becomes difficult to attribute effects to a particular component.

Ramirez et al. (2009) found no statistically significant differences between the experimental and control groups with regard to academic and test anxiety outcomes. The intervention in their study was used for a total of 12 hr. This finding challenges the idea that combined interventions could lead to larger gains than either intervention alone due to synergistic effects (Vansteenkiste et al., 2004). However, it is also unclear how much of either intervention contained evidence-based anxiety-management practices. It could also be that the type of anxiety-management practices provided did not address the underlying reason for the anxiety. For example, students in the Ramirez et al. study were underperformers and in a minoritized group, indicating that they could be experiencing stereotype threat, which would have implications for the appropriate interventions to improve academic outcomes. Perhaps further research is needed to determine how best to combine an anxiety-management element within the academic intervention and which elements are needed, for how long, and for whom.

Four studies in our corpus incorporated a metacognitive component within the academic intervention (Collingwood & Dewey, 2018; Kramarski et al., 2009; Obergriesser & Stoeger, 2015; Tok, 2013). Metacognition has been found to be an important element of self-regulated learning (Winne, 2017) and to strongly predict academic achievement (Schneider & Artelt, 2010). Considering that academic anxiety (specifically, math anxiety) has been linked to reduced control of cognitive processes and that self-regulation has been conceptualized as related to control, it might be worthwhile to better understand the connection between academic anxiety and self-regulated learning within the context of improving academic achievement (Gabriel et al., 2020). We were unable to conduct a moderator analysis due to an inadequate sample of effects; however, of the effect size data provided, these source studies showed no statistically significant improvement in academic anxiety when the academic intervention embedded a metacognitive component. Perhaps further research is needed to better determine which components are needed to address specific student academic and anxiety-related characteristics.

Three models were described in the introduction of this synthesis to explain the relation between anxiety and achievement: (a) poor achievement could lead to anxiety, (b) anxiety could negatively influence achievement, or (c) the two outcomes could influence each other in a bidirectional manner. Overall, the academic interventions included in this synthesis improved academic achievement outcomes but did not change academic anxiety outcomes. Given this information, these findings do not align well to the hypothesis that academic anxiety is solely a product of poor achievement. If poor achievement were the primary cause of academic anxiety, we may expect improvements in academic achievement to be associated with reduction in anxiety. Previous test anxiety research also found that knowledge deficit models do not fully explain academic anxiety and are moving toward more transactional approaches of acknowledging the importance of individual learner and social and environmental characteristics in anxiety responses (Sawyer & Hollis-Sawyer, 2005). Though not the aim of this analysis, one example of why a transactional approach is important to consider is that special populations can experience academic anxiety, such as stereotype threat, in response to individual characteristics and social factors (Sawyer & Hollis-Sawyer, 2005). Stereotype threat explains the phenomenon that academic anxiety can increase when relevant negative stereotypes become salient and when academic failure would confirm the negative stereotype (Osborne et al., 2010).

Perhaps the academic interventions would have demonstrated significant effects if they had been tested at a later time point. Unfortunately, none of the source studies in this analysis included follow-up data. Perhaps it could take time to see positive effects and these effects would be seen only if follow-up data were reported. One of the source studies covered a 3-year period (Barner et al., 2016), yielding no significant effects on the anxiety outcomes. Follow-up and more-frequent data during and after an academic intervention measuring academic anxiety could help to determine whether there is individual variance. Moreover, anxiety can have a recurrent presentation (Scholten et al., 2013), indicating that follow-up data and more frequent data points for anxiety outcomes could help us better understand variability or change within individual students.

Limitations

One major limitation of this synthesis is its limited statistical power due to the small number of studies with elementary school students that met our inclusion criteria. Although the number of effect sizes adequately powered our estimate for the overall effect size, we did not have enough effect sizes to be able to run a moderator analysis. We had hoped to conduct a moderator analysis between standardized and nonstandardized measures but could not due to the limited number of studies that qualified for this analysis. Previous research has indicated that standardized academic measures typically yield lower effect sizes (Scammacca et al., 2015). Many of the academic achievement and academic anxiety measures in this study were unstandardized, which may have resulted in a larger overall effect size than if the measures had all been standardized.

Another limitation in this study is related to academic anxiety measures. This review included studies with a range of measure types, which made it difficult to compare. The types of questions or rating systems included Likert-type scales, students imagining themselves in different situations, and yes/no response questions. In addition, it was not always clear which dimension of academic anxiety was being measured (affective, cognitive, mixed, or other). Although we attempted to parse which dimension of academic anxiety was measured in each study, similar to previous research (Namkung et al., 2019), not all studies indicated which dimension they measured, and we were unable to locate all of the measures to conduct our own analysis of these data. Considering that affective dimensions have been found to be significantly related to poor math achievement (Ho et al., 2000) and that the cognitive dimension has been found to be more strongly related to achievement for test anxiety (Morris et al., 1981), it may be important for future research to indicate which dimension of academic anxiety is being measured.

Furthermore, our corpus of studies included a large range of measures and, unfortunately, research is lacking regarding whether and to what extent these measures are interchangeable (Zeidner & Matthews, 2005). Measures for younger children are still being validated and developed (e.g., math anxiety; Namkung et al. 2019). To complicate this further, not only are there numerous types of academic anxieties, but also there are subtypes of academic anxiety, which should have implications for assessment (Gierl & Bisanz, 1995).

Implications for Research

Measures provide an important role in understanding the relationship between anxiety and learning (Ma, 1999; Mikami, 2019). Research should seek to develop and use standardized norm-referenced measures to better facilitate comparability. Furthermore, researchers should provide information about measures' dimension (e.g., affective, cognitive) given research indicating that the dimensions can differ in their association with performance (Ho et al., 2000). Multi-informant assessment remains a key priority in this field (Baldwin & Dadds, 2007), and in this synthesis, anxiety was only self-reported. Moreover, researchers have suggested studying academic anxiety alongside general clinical measures because they interact to produce differential levels of ongoing state anxiety (Snyder & Katahn, 1970). Evaluating measures together can provide more information than one measure alone, such as characteristics of test anxiety that are not captured in a general anxiety measure (Putwain et al., 2021).

We added sensitivity analysis to demonstrate the strength of our conclusions across models. The degrees of freedom (> 4) indicates that the results of the intercept-only model are reliable. Also, the conclusions are the same, even when we run a simplified model where the outcome types are uncorrelated. Therefore, we are confident in our main effect findings. However, although the study is fully powered, future research is needed. Only four of the studies were of high quality and only one of those studies was from the last decade.

Future researchers should consider experimental design and analysis methods that would help us better understand the causal relationship between academic anxiety and academic achievement. Longitudinal data with multiple data points during and after intervention can add to our understanding of the causal direction of the relation between academic anxiety and performance (similar to Ma & Xu, 2004, who used a cross-lagged structural equation model). Also, meta-analysis that compares longitudinal and concurrent correlations can also help to explain the causal relationship (Namkung et al., 2019). This underscores the importance of future intervention research using longitudinal experimental designs.

Finally, researchers in this field should consider the questions of what, for whom, and under what circumstances to better understand how to address anxiety within the context of learning, as it seems the underlying mechanism (i.e., the barrier to success or the reason for the anxiety) may be important in providing effective tailored interventions (Cassady, 2010; Ergene, 2003). For example, students experiencing academic anxiety in response to lack of content knowledge, in response to fears about evaluation, or as a response to stereotype threat would likely need different interventions. Perhaps the more individualized an intervention, the better the outcomes. To learn more about academic anxiety, researchers might consider measuring academic anxiety frequently throughout the intervention cycle and adapting interventions to responders and nonresponders. Furthermore, follow-up and longitudinal data would help researchers better understand the effects or recurrent nature of academic anxiety and may provide useful information for tailoring interventions.

Implications for Practice

This review provides guidance related to the association between academic achievement and academic anxiety symptoms because we found that academic interventions do not appear to address academic anxiety. As such, practitioners should consider that academic anxiety might need to be addressed more directly. A systematic review of school-based, teacher-led anxiety interventions yielded four studies, and all reported effectively lowering anxiety symptoms, indicating that programs addressing anxiety directly (through cognitive behavioral therapy or self-esteem enhancements) can reduce anxiety symptoms (Tutsch et al., 2019). These findings, along with a growing body of research on the importance of considering that anxiety might interfere with academic achievement (Fletcher & Grigorenko, 2017; Ramirez et al., 2013), suggest that educators might screen for academic anxiety, especially if students are struggling academically (e.g., poor readers should be assessed for anxiety; Francis et al., 2019), and use this information (along with students' strengths and weaknesses and other behavioral influences) when prescribing effective interventions (Fletcher & Grigorenko, 2017).

Conclusion

Seeking to understand the relationship between anxiety and academic performance is not a new endeavor. One challenge in understanding the relationship between anxiety and learning is the many variables to consider: age and stage in development, type of anxiety, environmental influences, and whether anxiety preceded academic difficulties or vice-versa. With research spread thin over such a breadth of time, it is challenging to draw conclusions; however, this synthesis suggests various ideas to further this line of research. We suggest future research considering a direct approach to addressing anxiety levels. We also suggest that researchers use multiple standardized academic anxiety measures, including a clinical anxiety measure for comparative purposes. Anxiety continues to be a growing public health concern, and many questions about the relationship between anxiety and academic achievement still remain unanswered. Thus, future research should bring attention to the development of evidence-based practices that consider anxiety and academic achievement as ageless aspects of the human condition that, if understood and appropriately addressed, can enable students to reach their academic potential.

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Data Availability

Supplementary analysis and replication materials for this study are available on the Open Science Framework at https://osf.io/y4uza/

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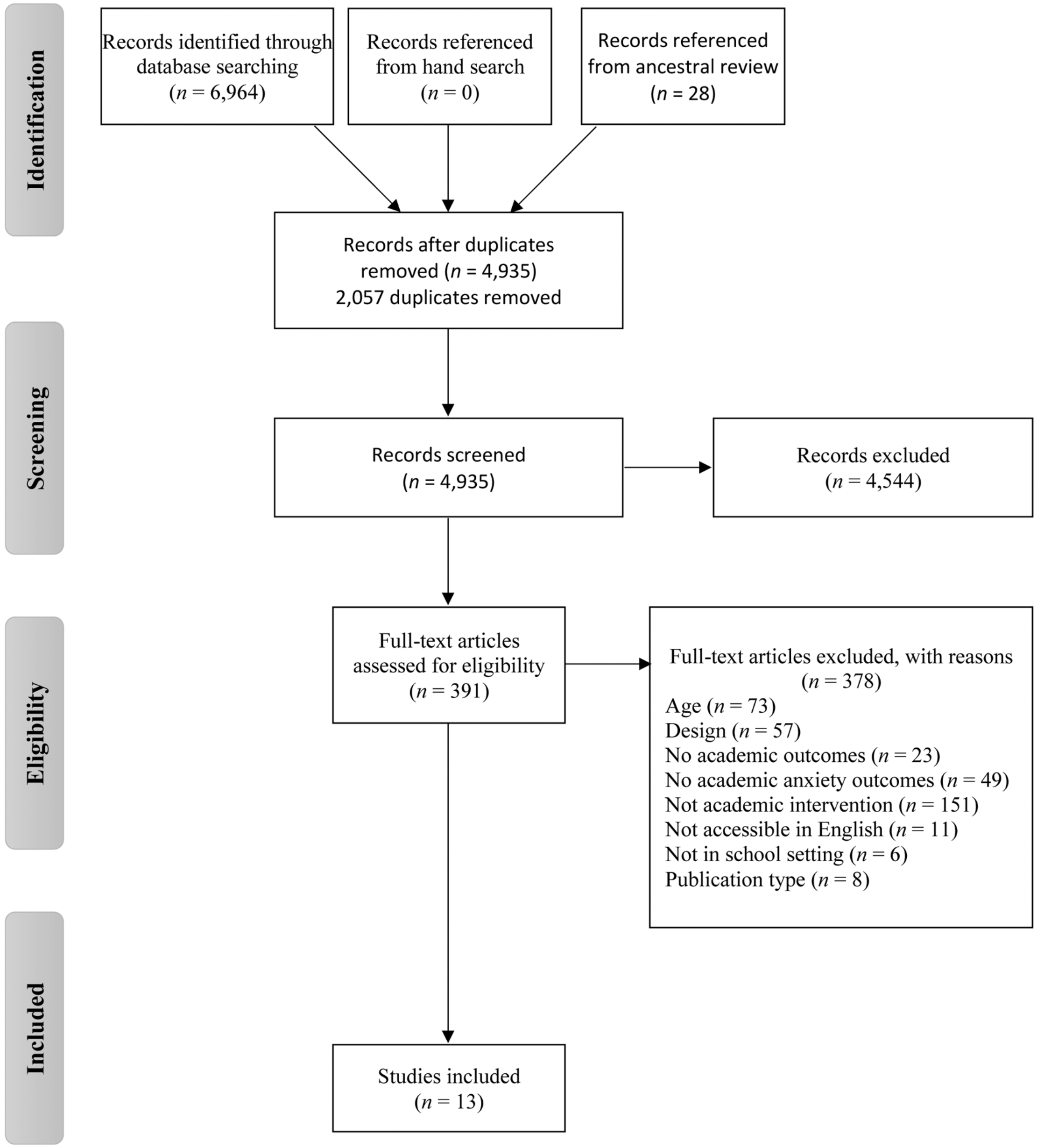

Figure 1.
PRISMA Diagram
Note. Among the 13 studies included, 11 studies contributed enough information to be included in the quantitative meta-analysis.

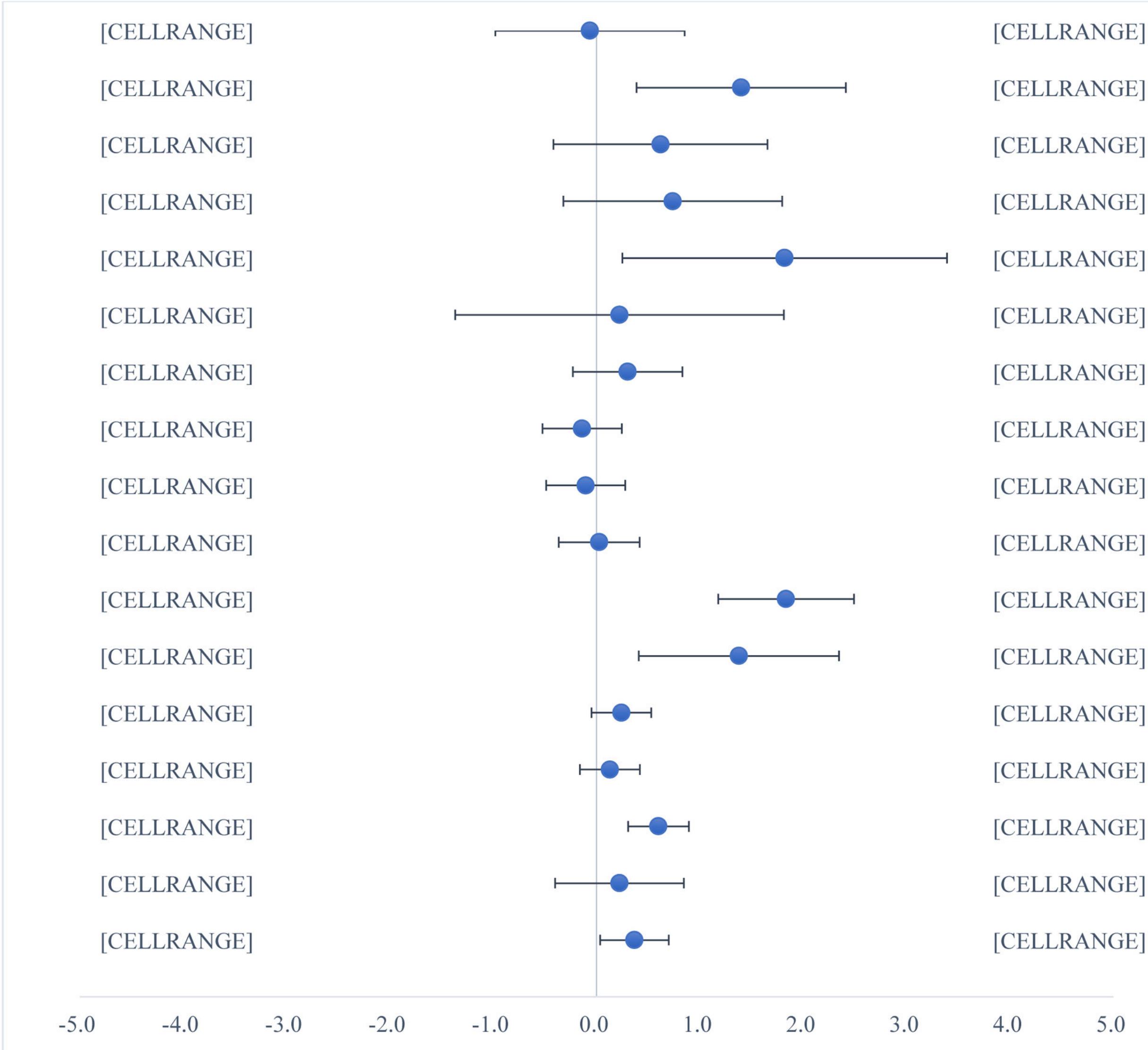

Figure 2.
Forest Plot: Strength of the Standardized Mean Difference Between Treatment and Comparison on Academic Achievement Outcomes
Effect Size [95% CI]
Note. T1 = Treatment 1; T2 = Treatment 2; T3 = Treatment 3; C1 = Comparison 1; C2 = Comparison 2.

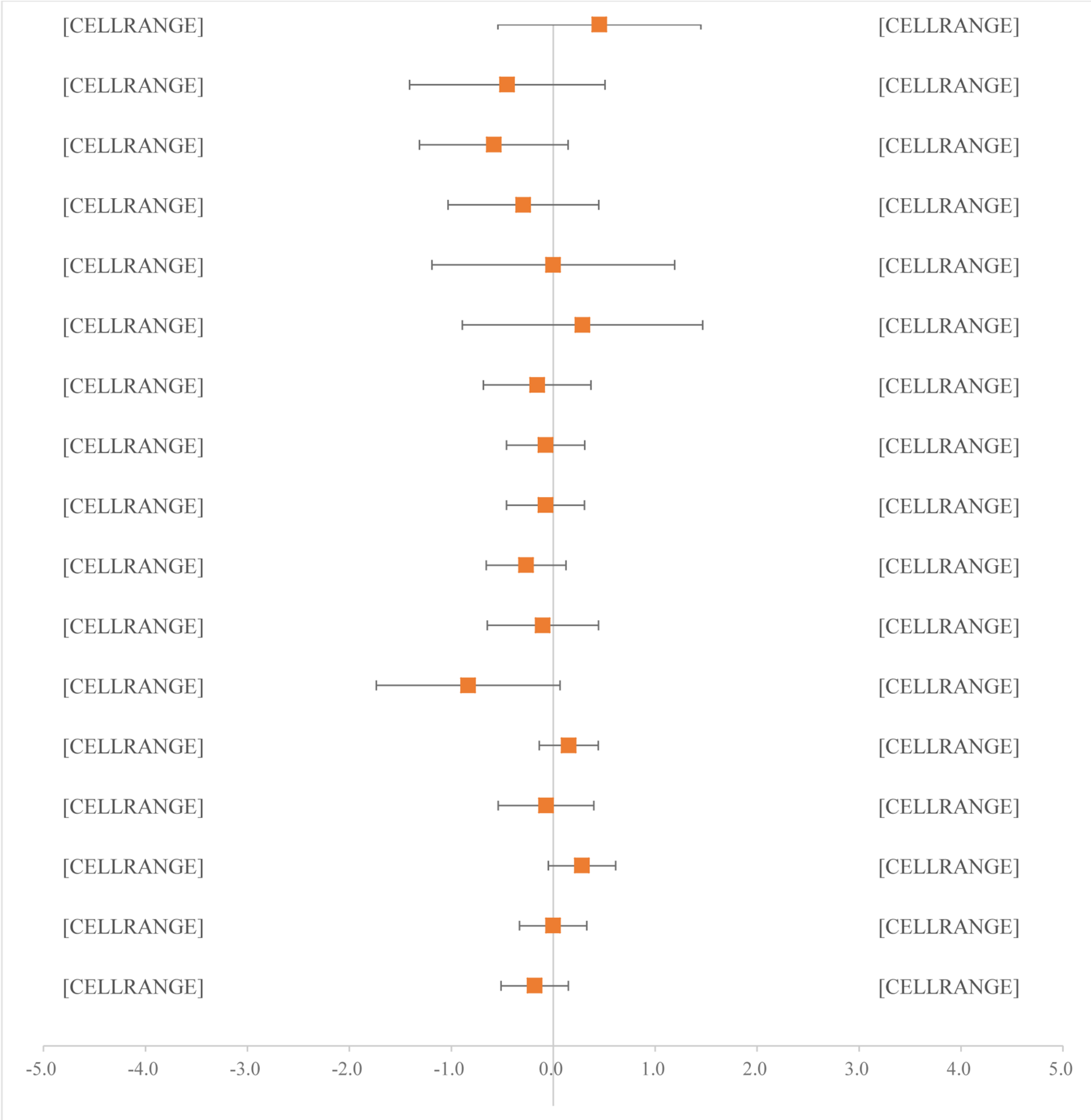

Figure 3.

Forest Plot: Strength of the Standardized Mean Difference Between Treatment and Comparison on Academic Anxiety Outcomes

Effect Size [95% CI]

Note. T1 = Treatment 1; T2 = Treatment 2; T3 = Treatment 3; C1 = Comparison 1; C2 = Comparison 2; MAS = Math Anxiety Scale; SMAC = Scale of Mathematics Anxiety in Class; SMAT = Scale of Mathematics Anxiety During Tests.

Table 1

Descriptive Characteristics for Studies

Characteristic	***n***	**%**
Publication year		
1970s	1	8
1980s	2	15
1990s	0	0
2000s	4	31
2010-present	6	46
Study design		
RCT	8	62
QED	5	38
Academic measure type		
Standardized	6	46
Unstandardized	6	46
Both	1	8
Academic Anxiety measure type		
Standardized	8	62
Unstandardized	4	31
Both	1	8
Content area		
Math	9	69
Literacy	3	23
Science	1	8
Instructional group size		
One-on-one[a]	1	8
Nine and more	6	46
NR	6	46
Interventionist		
Teacher[b]	8	62
Researcher	1	8
Other	4	31

Note. RCT = random control trial; QED = quasi-experimental design; NR = not reported.

[a]Individual computer time.

[b]General education teacher.

Table 2

Information Regarding Characteristics of Studies, Students, and Interventions

Study	Design	Research quality	*N*	Gender	Grade	Risk type	SES	Content area	Description of conditions	Implementer	Group size	Total hours	Total sessions
Barner et al. (2016)	RCT	Medium	187	NR	2–4	No risk	Low	Math	T: Mental Abacus C: Supplemental math training	Other[a]	NR	NR[b]	NR
Beard (2003)	RCT	High	34	M = 17 (50%) F = 17 (50 %)	4	Mixed[c]	Low	Math	T: Integrated math and literacy curriculum C: Traditional math curriculum	Researcher	Whole class	27	27
Chalip & Chalip (1978)	RCT	High	32	M = 16 (50%) F = 16 (50 %)	3–4	Mixed	NR	Literacy	T1: Co-operative learning T2: Mixed co-operative & individual learning C: Individual learning	General education teacher	10–11	5.75	23
Colling wood & Dewey (2018)	RCT	High	144	NR	4	No risk	Mixed	Math	T: Thinking your problems away C: Control/ wait list	Other[d]	NR[e]	9	12
Jansen et al. (2013)	RCT	Medium	207	M = 110 (53%) F = 97 (47 %)	3–6	Mixed[f]	NR	Math	T1: Math Garden Difficult[g] T2: Math Garden Medium[h] T3: Math Garden Easy[i] C: BAU	Other	Individual computer time	3–7.5	18–30
Kramarski et al. (2009)	RCT	Medium	140	M = 72 (51%) F = 68 (49 %)	3	Mixed[j]	NR	Math	T: Metacognitive self-regulation strategy C: Regular math lesson	General education teacher	NR	16	16
Lysenko et al. (2016)	QED	Low	186	NR	1	No risk	NR	Math	T: ELM C: BAU	General education teacher	NR	NR	NR
Mevarech (1985)	QED	Medium	204	NR	3	No risk	Low	Math	T1: Computer-assisted individualized instruction T2: Computer-assisted traditional instruction C1: Individualized instruction C2:	General education teacher	Whole class	NR	NR

Study	Design	Research quality	*N*	Gender	Grade	Risk type	SES	Content area	Description of conditions	Implementer	Group size	Total hours	Total sessions
									Traditional instruction				
Mevarech & Ben-Artzi (1987)	QED	Low	245	NR	6	No risk	NR	Math	T1: CAI with fixed feedback T2: CAI with adaptive feedback C: Traditional instruction with no CAI	General education teacher	NR	NR	NR
Obergriesser & Stoeger (2015)	QED	Low	24	NR	4	Gifted	NR	Science	T: Text-reduction strategy intervention C: Regular instruction	General education teacher	Whole class	23–35	35
Ramirez et al. (2009)	RCT	High	58	M = 36 (62%) F = 22 (38 %)	3	AR, ELLs	Low	Literacy[k]	T: Cuento therapy C: Drill and practice reading summer school	Other	9–10	12	12
Schweiker-Marra & Marra (2000)	RCT	Medium	29	NR	5	AR[1]	Low	Literacy[m]	T: Prewriting C: Whole language; no writing strategies	General education teacher	NR	NR[n]	NR
Tok (2013)	QED	Medium	55	M = 26 (47%) F = 29 (53%)	6	No risk	NR	Math	T: KWL strategy C: Traditional teaching	General education teacher	24	32	32

Note. RCT = randomized control trial; QED = quasi-experimental design; *N* = sample size; M = male; F = female; NR = not reported; AR = academic risk; ELLs = English language learners; T1 = Treatment 1; T2 = Treatment 2; T3 = Treatment 3; C = Comparison; C1 = Comparison 1; C2 = Comparison 2; CAI = Computer-assisted instruction; KWL = know-want-learn strategy; BAU = business as usual; ELM = Emerging literacy in mathematics.

[a]Other specialists.

[b]3 hr per week for 3 years.

[c]Only two gifted students and two special education students with the remainder of the students being of average ability.

[d]Uncertified paraprofessionals.

[e]Small groups.

[f]Students were selected randomly from two schools with 61% and 31% risk of falling behind academically.

[g]60% targeted success rate.

[h]75% targeted success rate.

[i]90% targeted success rate.

[j]Included lower and higher achievers.

[k]Reading-focused intervention during mandatory remedial summer school program.

[l]Majority performed in the lowest quartile on their state test.

[m]Writing intervention.

[n] 2 hr daily for 6 months (estimated at 240 hr).

Table 3

Study Information Regarding Measures and Effect Sizes

Study	Academic achievement outcomes			Academic anxiety outcomes			
	Measure	**Measure type**	**Effect size (SE) [95% CI]**	**Anxiety type**	**Measure**	**Measure type**	**Effect size (SE) [95% CI]**
Barner et al. (2016)	1. WJ-IIIC: Calculation 2. WIAT-III: Math fluency Researcher-developed arithmetic skills assessment	Both	WJ-IIIC: 0.24 (0.15) [−0.05, 0.53] WIAT-III: 0.13 (0.15) [−0.16, 0.42] Arithmetic: 0.60 (0.15) [0.30, 0.89]	Math	Math Anxiety Questionnaire (adapted from Ramirez et al., 2013)	Nonstandardized	0.15 (0.15) [−0.14, 0.44]
Beard (2003)	Math achievement from the Saxon blackline test masters book	Standardized	0.22 (0.78) [−1.37, 1.81]	Math	Math Anxiety Scale for Children	Standardized	0.29 (0.58) [−0.89, 1.47]
Chalip & Chalip (1978)	Noun and Verb Identification Test	Nonstandardized	T1 & C1: −0.06 (0.44) [−0.98, 0.85] T2 & C1: 1.40 (0.49) [0.39, 2.41]	Test	Test Anxiety Scale (Sarason et al., 1960)	Standardized	T1 & C1: 0.45 (0.47) [−0.54, 1.45] T2 & C1: −0.45 (0.46) [−1.41, 0.51]
Collingwood & Dewey (2018)	Access Mathematics (McCarty, 2008)	Standardized	0.37 (0.17) [0.03, 0.70]	Math	1. Math Anxiety Scale (MAS) 2. Scale of Mathematics Anxiety in Class and during Tests (SMAC and SMAT)	Standardized	MAS: 0.28 (0.17) [−0.05, 0.61] SMAC: −0.00 (0.17) [−0.33, 0.33] SMAT: −0.18 (0.17) [−0.51, 0.15]
Jansen et al. (2013)	Tempo Test Automatiseren: 1. Addition-subtraction Total	Nonstandardized	T1 & C1: −0.14 (0.19) [−0.52, 0.24][a] T2 & C1: −0.11 (0.19) [−0.49, 0.28][a] T3 & C1: 0.03 (0.20) [−0.37, 0.42][a]	Math	Math Anxiety Scale for Children (translated into Dutch and modified)	Nonstandardized	T1 & C1: −0.07 (0.19) [−0.46, 0.31] T2 & C1: −0.08 (0.19) [−0.46, 0.31] T3 & C1: −0.27 (0.20) [−0.66, 0.13]
Kramarski et al. (2009)	Problem Solving Tasks: Basic, complex tasks, and transfer tasks	Nonstandardized		Math	Questionnaire adapted from Sarason (1980) and Midgley (2000)	Nonstandardized	
Lysenko et al. (2016)	Canadian Achievement Test - Math subscale	Standardized	0.22 (0.32) [−0.40, 0.84]	Math	Academic Emotions Questionnaire - Elementary	Standardized	−0.07 (0.24) [−0.54, 0.40]

Study	Academic achievement outcomes			Academic anxiety outcomes			
	Measure	**Measure type**	**Effect size (SE) [95% CI]**	**Anxiety type**	**Measure**	**Measure type**	**Effect size (SE) [95% CI]**
					School - Abridged		
Mevarech (1985)	Arithmetic Achievement Test: 1. Overall 2. Computation 3. Comprehension	Standardized	T1 & C1: 0.62 (0.52) [−0.42, 1.65][b] T2 & C2: 0.74 (0.53) [−0.32, 1.80][b]	Math	Math Anxiety measure (Mevarech & Rich, 1984)	Nonstandardized	T1 & C1: −0.58 (0.37) [−1.31, 0.15] T2 & C2: −0.29 (0.37) [−1.03, 0.45]
Mevarech & Ben-Artzi (1987)	Arithmetic Achievement Test	Standardized		Math	1. Mathematics Anxiety Rating Scale 2. Test Anxiety Scale	Both	
Obergriesser & Stoeger (2015)	Identification of main ideas	Nonstandardized	1.38 (0.47) [0.41, 2.35]	School related	Achievement Emotions Questionnaire - Anxiety	Standardized	−0.84 (0.43) [−1.74, 0.07]
Ramirez et al. (2009)	Texas Assessment of Knowledge and Skills	Standardized	0.30 (0.26) [−0.23, 0.83]	Test	Test Anxiety Scale for Children	Standardized	−0.16 (0.26) [−0.69, 0.37]
Schweiker-Marra & Marra (2000)	Holistic rubric for narrative writing (Froc et al., n.d.)	Nonstandardized	1.82 (0.77) [0.25, 3.40]	Writing	Writing Apprehension Scale (Daly & Miller, 1975)	Standardized	0.00 (0.58) [−1.19, 1.19]
Tok (2013)	Math achievement test	Nonstandardized	1.83 (0.33) [1.18, 2.49]	Math	Math Anxiety Scale (Bindak, 2005)	Standardized	−0.10 (0.27) [−0.65, 0.44]

Note. Effect sizes were not calculated in two studies (Mevarech & Ben-Artzi, 1987; Kramarski et al., 2009) due to the insufficient information. WJ-IIIC = Woodcock-Johnson Tests of Achievement; WIAT-III = Wechsler Individual Achievement Test.

[a]Effect size was calculated based on the addition-subtraction subtest score because the author stated that the total score had ceiling effects.

[b]Effect size was calculated based on the overall score of ATT.