Interventions Within the Scope of Occupational Therapy to Improve Children’s Academic Participation: A Systematic Review

Lenin C. Grajo, Catherine Candler, Amanda Sarafian

Importance: Occupational therapy practitioners evaluate students’ ability to participate in school and may provide services to improve learning, academic performance, and participation.

Objective: To examine the effectiveness of interventions within the scope of occupational therapy practice to improve academic participation of children and youth ages 5–21 yr.

Data Sources: We searched MEDLINE, PsycINFO, CINAHL, OTseeker, and Cochrane databases for articles published from 2000 to 2017 using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Study Selection and Data Collection: Within the scope of occupational therapy practice and focused on children ages 5–21 yr.

Findings: Forty-six studies were included, based on three themes: (1) interventions to support participation and learning in the classroom; (2) interventions to support motivation and participation in literacy, including combined reading, written expression, and comprehension; and (3) interventions to support handwriting. Low strength of evidence supports the use of weighted vests and stability balls, and moderate strength of evidence supports the use of yoga to enhance educational participation. Moderate strength of evidence supports the use of creative activities, parent-mediated interventions, and peer-supported interventions to enhance literacy participation. Strong evidence supports therapeutic practice for handwriting intervention, and low strength of evidence supports various handwriting programs as replacement or additional instructional strategies to enhance handwriting abilities.

Conclusions and Relevance: More rigorous studies are needed that are conducted by occupational therapy practitioners in school-based settings and that use measures of participation and academic outcomes.

What This Article Adds: This systematic review provides occupational therapy practitioners with evidence on the use of activity-based and occupation-centered interventions to increase children’s participation and learning in school.

Learning and academic achievement are primary childhood endeavors. Occupational proficiency in the role of student is essential for children’s successful participation in school. Educational participation is evidenced by engagement in classroom activities that are required for learning and participating in school (American Occupational Therapy Association [AOTA], 2014). Indicators of successful participation in the classroom include on-task behaviors, following classroom rules, engagement, response time, attention, time spent seated, duration of independent work and work with peers, academic performance, communication, and classroom contribution (Burgoyne & Ketcham, 2015; Butzer et al., 2015; Fedewa et al., 2015; Hodgetts et al., 2011). Students with disabilities participate less than students without disabilities in school-related activities (Coster et al., 2013). Occupational therapy practitioners evaluate students’ ability to participate in school and may provide a continuum of services to improve learning, academic performance, and participation.

Literacy, as related to educational participation, is the ability to read and write and to express oneself in written form (Frolek Clark, 2016). Handwriting is a component of literacy frequently addressed by occupational therapy practitioners (Hoy et al., 2011). Impairment in handwriting has been linked to barriers in fluent composition and productive writing and academic achievement are primary childhood endeavors. Occupational proficiency in the role of student is essential for children’s successful participation in school. Educational participation is evidenced by engagement in classroom activities that are required for learning and participating in school (American Occupational Therapy Association [AOTA], 2014). Indicators of successful participation in the classroom include on-task behaviors, following classroom rules, engagement, response time, attention, time spent seated, duration of independent work and work with peers, academic performance, communication, and classroom contribution (Burgoyne & Ketcham, 2015; Butzer et al., 2015; Fedewa et al., 2015; Hodgetts et al., 2011). Students with disabilities participate less than students without disabilities in school-related activities (Coster et al., 2013). Occupational therapy practitioners evaluate students’ ability to participate in school and may provide a continuum of services to improve learning, academic performance, and participation.

Literacy, as related to educational participation, is the ability to read and write and to express oneself in written form (Frolek Clark, 2016). Handwriting is a component of literacy frequently addressed by occupational therapy practitioners (Hoy et al., 2011). Impairment in handwriting has been linked to barriers in fluent composition and productive
engagement in academic tasks (Santangelo & Graham, 2016). The reading component of literacy can also be un-
derstood from the perspective of occupational engagement and participation. When a child reads, he or she engages
with a task object within a context, and many variables within this context influence participation (Grajo et al., 2016).

According to Law (2002), participation in occupations has several dimensions, which include one’s preferences and
interests in activities, what one does, where and with whom one does it, and how much enjoyment and satisfaction one
finds in participating in these activities. Although rarely addressed directly, literacy does appear in the occupational
therapy literature. The third edition of the Occupational Therapy Practice Framework: Domain and Process (OTPF–3;
AOTA, 2014) includes literacy (reading and writing) as part of formal education participation. Literacy thus is included
within the domain of occupational therapy, yet the provision of occupational therapy specifically to children having
reading problems is not well addressed (Grajo et al., 2016). Likewise, few studies have analyzed the effectiveness of
occupation-based interventions to address handwriting and educational participation. There is a significant gap in the
literature regarding interventions for school-age children aimed at the participation level.

The purpose of this systematic review was to provide occupational therapy practitioners with evidence on the use of
activity-based or occupation-centered interventions to increase children’s participation and learning in school. This
study aimed to answer the question, What is the evidence for the effectiveness of interventions within the scope of
occupational therapy practice to improve learning, academic achievement, and successful participation in school for
children and youth ages 5–21?

Method
This systematic review was supported and funded by AOTA as part of its Evidence-Based Practice Project. The search
terms and search strategy were developed by an AOTA staff member and research methodologist, a medical librarian,
and an advisory group (Table 1). Searches were conducted of the MEDLINE, PsycINFO, CINAHL, OTseeker, and
Cochrane databases. The initial search returned 89,461 results with dates ranging from 2000 to 2017. After initial
review and screening by the AOTA research methodologist, the authors screened 5,310 results for inclusion in the
systematic reviews. Hand searching located an additional 12 articles for further screening. Articles were critically
appraised using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines
(Moher et al., 2009).

Inclusion Criteria
To be included in the systematic review, articles were required to be published in a peer-reviewed journal; written in
English; published between January 2000 and March 2017; Level I, II, or III studies; within the scope of occupational
therapy practice (i.e., activity or occupation based and within the domain of practice and process of occupational
therapy as guided by the OTPF–3); and focused on children ages 5 to 21 yr and must describe intervention studies
conducted by school practitioners and researchers or other health professionals (i.e., not necessarily occupational
therapy practitioners), as long as the outcomes were within the scope of occupational therapy.

In addition, included studies needed to use specific outcome measures relating to academic participation. We
operationalized three themes for study outcomes on the basis of the literature review and collaborative consultation with
the AOTA Evidence-Based Project team and staff methodologist:
1. Educational participation—for example, classroom on-task behaviors, engagement, and attention; ability to follow
classroom rules; amount of time spent seated to attend to classroom tasks; amount of time spent on independent
work and work with peers; academic performance; and amount of time and frequency of communication and
classroom contribution
2. Literacy participation—for example, frequency of reading and writing; motivation for and interest in reading and writing; positive self-concept, perception of mastery and competence, and attitudes regarding reading and writing; time spent engaging in print; and perception of performance and satisfaction in reading and writing engagement.

3. Handwriting—for example, component skills for handwriting (e.g., visual, motor, sensory); writing rate or speed, legibility, and accuracy; and frequency and amount of handwriting participation.

Exclusion Criteria

Studies were excluded from the systematic review if they were dissertations, theses, presentations, or proceedings; published before or after the review range; Level IV or V studies, regardless of outcomes measured; or studies of interventions for parents and service providers with no child-focused outcomes. Studies with outcomes that did not fall within the three outcome themes were not included; for example, we excluded studies examining outcomes of social participation in schools, engagement in physical activity, life skills and employment, driver education, after-school programs, and active commuting to school.

Screening

Of the 5,322 articles selected during title and abstract screening, we screened 456 more closely to determine whether a full review was warranted and further eliminated 371 articles (Figure 1). At least two researchers reviewed the full text of the 85 remaining articles to determine whether they met the inclusion and exclusion criteria. If reviewers could not reach a consensus on whether to include an article, they consulted with AOTA staff and the research methodologist.
AOTA staff and the research methodologist also reviewed all studies to ensure they met the criteria. A total of 46 articles met the inclusion criteria and are included in this systematic review.

We analyzed the studies on the basis of level of evidence (design), quality (scientific rigor), and significance of findings and entered our findings in an evidence table (Table A.1 in the Appendix). In addition, we assessed the intervention studies for risk of bias using the Cochrane Collaboration tool (Higgins et al., 2011; Table A.2) and the systematic reviews using the AMSTAR tool (Shea et al., 2007; Table A.3). No overall assessments of risk of bias were identified that might affect the cumulative analysis. For quality control, the AOTA research methodologist and project staff reviewed all tables and provided feedback.

We evaluated the strength of evidence for each outcome theme according to the guidelines from the U.S. Preventive Services Task Force (2018):

- **Strong evidence** includes consistent results from at least two randomized controlled trials (RCTs) that are well designed and well conducted.
- **Moderate evidence** indicates at least one RCT or two or more moderate-quality studies. Confidence is constrained by inconsistency of findings or by the number, size, or quality of the individual studies.
Low evidence indicates that the evidence is insufficient because of a small number of studies, flaws in study design or method, inconsistency in results, or lack of information on important outcomes.

**Results**

**Educational Participation**
Eight articles (4 Level I, 1 Level II, 3 Level III) met the criteria for the review and provide evidence related to activity-based interventions addressing educational participation in school. Risk of bias of these studies ranged from low to high, and findings regarding effectiveness were mixed. Of the 8 studies, only 1 was conducted by occupational therapy clinicians and researchers (Hodgetts et al., 2011); the rest were conducted by exercise physiologists, educational psychologists, physical and recreational therapists, neuropsychologists, and special education researchers.

**Weighted Vests**
Low evidence from 2 studies addresses the use of weighted vests in the classroom to increase participation and academic achievement. A Level II single-case withdrawal study measured classroom behaviors in children with autism spectrum disorder (ASD) during three phases: without wearing a vest, wearing a vest with weight, and wearing a vest without weight (Hodgetts et al., 2011). Sitting time, attention to task, and seated behavior did not significantly improve when wearing weighted vests. A systematic review found 13 group or single-case studies of the use of weighted vests by students with ASD (Taylor et al., 2017). Eight of the studies did not support the use of weighed vests to increase in-seat behaviors and engagement. Five studies showed strong support for the use of weighted vests during classroom activities to decrease off-task behavior time; however, the results of these studies do not meet What Works Clearinghouse (WWC) criteria for evidence-based practice because of the limited number of participants (n = 5 total) and limited geographic regions represented. Therefore, the evidence is insufficient to support weighted vest intervention for children with ASD in the classroom.

**Stability Balls**
Low evidence from three studies addresses the use of stability balls in the classroom to increase educational participation. An RCT examined the use of stability balls versus classroom chairs in second-grade general education classrooms throughout the day (Fedewa et al., 2015). Students using stability balls significantly increased their interaction with teachers, whereas students using standard classroom chairs spent more time on task when working independently and with peers. Use of stability balls did not significantly improve on-task behavior or achievement levels in math and literacy.

A Level III comparison of second-grade students’ classroom behaviors while using classroom chairs versus stability balls found significant increases in observed on-task behaviors, as measured by focused activity and following classroom rules, while using stability balls (Burgoyne & Ketcham, 2015). A Level III study examined classroom behaviors while using a stability ball in third- through fifth-grade students diagnosed with attention deficit hyperactivity disorder; descriptive results indicated an increase in average time spent seated and on-task time when seated on a stability ball (Fedewa & Erwin, 2011).

**Yoga**
Moderate evidence based on 3 studies supports the effectiveness of yoga interventions to enhance school participation. A Level III study of the Yoga4 Classroom program for second-grade students resulted in significant improvements in social interaction, attention, and on-task academic performance as reported by teachers (Butzer et al., 2015).

An RCT examined use of a manualized yoga-based social-emotional wellness promotion program, Transformative Life Skills, with sixth- and ninth-grade students to address stress, physical and emotional awareness, self-regulation,
and healthy relationships (Frank et al., 2017). The intervention group had significantly fewer unexcused absences and significantly higher levels of school engagement. Finally, a systematic review of 12 studies examined the effectiveness of yoga programs for children with and without disabilities delivered in school. Results were inconclusive because of high risk of bias (Serwacki & Cook-Cottone, 2012); however, significant improvements in communication and classroom contribution were exhibited by children with learning disabilities and emotional and behavioral problems compared with control groups.

**Literacy Participation**

Thirteen studies (6 Level I, 6 Level II, 1 Level III) examined interventions to promote literacy participation. The studies were rated as having an overall moderate risk for bias, and all but one (Sylva et al., 2008) had a low risk of reporting bias. Only one study was conducted by occupational therapy clinicians and researchers (Grajo & Candler, 2016); the rest were conducted by reading specialists, special education researchers, and educational psychologists. Interventions varied in format (groups vs. dyads vs. individuals) and duration (one time vs. multiple weeks). Level of evidence is reported separately for three types of intervention: embedded and supplemental creative literacy activities, parent-mediated interventions, and peer-supported reading participation.

All studies used skill-level outcome measures (e.g., phonological processing, receptive and expressive language tests, reading and writing tests). Five studies used standardized published assessments of behavior and attitudes toward reading (Chong et al., 2014; Chow et al., 2018; Grajo & Candler, 2016; Higgins et al., 2015; Lee, 2014). Four studies used author-developed questionnaires on reading attitudes (Kim & Guryan, 2010; Saint-Laurent & Giasson, 2005; Steiner, 2014; Sylva et al., 2008). Two studies used standardized literacy environment assessments (Jordan et al., 2000; Ullery et al., 2014).

**Embedded and Supplemental Creative Literacy Activities**

Strong evidence based on four studies (2 Level I, 1 Level II, 1 Level III) supports the use of embedded creative and engaging literacy activities in classroom and supplemental intervention sessions. Two RCTs found that embedding creative discussions and rotating literacy activities in small groups led to significant increases in positive attitudes toward reading and improved self-concept as a reader (Chow et al., 2018; Higgins et al., 2015). Creative activities included having students create their own stories through drawings and interactive discussions.

A Level II study found that a pullout session in preschool integrating creative reading and writing activities to develop early literacy skills led to significant improvements in social behaviors that promote literacy engagement, such as attention and positive interaction with peers during literacy tasks (Chong et al., 2014). The creative activities included helping the children with beginning reading through word recognition, one-to-one word correspondence, visual discrimination, and phonemic awareness and with developing writing skills.

A Level III study integrated choice and creative participation during occupational therapy sessions in an 8-wk program and led to significant increases in perceived reading performance and satisfaction (Grajo & Candler, 2016). As part of the intervention, participants were allowed to identify their occupation-based reading goals (e.g., reading from an iPad for fun, reading at church in front of people) and to structure the format of the sessions.

**Parent-Mediated Interventions**

Moderate evidence based on 7 studies (3 Level I, 4 Level II) supports parent-mediated literacy interventions. An RCT found that enhancing parent–child interactions through a family literacy event led to significant increases in frequency of reading and number of books read (Kim & Guryan, 2010). It included a control group and two intervention groups: (1) a treatment group in which children received 10 self-selected books during summer vacation and (2) a treatment group...
with a family literacy group in which children received 10 self-selected books and were invited with their parents to attend three 2-hr summer literacy events.

An RCT evaluating nine family literacy workshops with an emphasis on successful reading engagement found significant changes in reading and writing scores but not in reading attitudes (Saint-Laurent & Giasson, 2005). The workshops facilitated reading with parents through adapting parental intervention to the child’s gradually increasing skills in reading during the school year, support for writing activities, and enjoyable home activities complementing the in-class teaching.

A Level II study using a parent-mediated literacy coaching approach led to significant increases in dyadic reading frequency and in mother-initiated dialogues with their children (Levin & Aram, 2012). Another Level II study of an 8-wk parent training program resulted in descriptively increased storybook reading frequency by parents and significant increases in children’s concepts about print (Steiner, 2014). A Level II study found that organized parent training sessions over 5 mo led to significant increases in home literacy activities and home literacy environments, but these increases were not significantly different from those of a control group that received the traditional curriculum (Jordan et al., 2000). An RCT examining a 70-hr parent training program found significant increases in children’s single-word reading scores but no changes in print concepts or phonological awareness compared with a control group that had access to a phone helpline (Sylva et al., 2008).

Peer-Supported Reading Participation

Moderate evidence based on 2 studies (1 Level I, 1 Level II) supports the effectiveness of peer-supported reading programs. A meta-analysis of 12 studies found that cross-age tutoring, direct reading tutoring, and tutoring with longer duration (16 hr or more) by student peers led to the highest effect sizes (Jun et al., 2010). A Level II study found that an 8-wk peer tutoring program led to significant improvements in reading attitude for recreational reading (Lee, 2014).

Handwriting

Twenty-five studies (10 Level I, 10 Level II, 5 Level III) related to handwriting legibility outcomes were included in this review. Nineteen studies were conducted by occupational therapy clinicians and researchers and the rest by special education teachers and researchers, educational psychologists, and developmental optometrists. Fifteen studies examined the handwriting performance of typically developing children and 10 studies of children with identified handwriting difficulties. Children with a confirmed diagnosis (e.g., autism, cerebral palsy, intellectual disabilities) were excluded from the studies. Participants’ average age was 7 yr (range = 4.6–12.0 yr).

The studies presented an array of interventions with an average of approximately 11 hr of training (range = 3–18 hr) over an average of 8 wk (range = 1–12 wk), with some of the interventions spaced over an academic year. Three studies used computer-based, technology-driven, or robotics-assisted interventions (Leung et al., 2016; Palsbo & Hood-Szivek, 2012; Poon et al., 2010). Results are presented separately for four intervention approaches: component skills, sensorimotor versus therapeutic practice, interventions in addition to usual classroom activities, and interventions in place of usual classroom activities.

Approaches to Address Component Skills

Handwriting is a complex task that involves an array of component skills, including visual perception, kinesthesia, in-hand manipulation, and visual–motor integration (Denton et al., 2006). Four RCTs with low risk of bias examined interventions that isolated and specifically addressed component skills hypothesized to underlie handwriting proficiency. None provided evidence for an effect on handwriting legibility of isolated activities addressing the components of visual perception, kinesthesia, or motor skill. One study showed no effect for kinesthetic training (Sudsawad et al., 2002).
The other 3 studies provided moderate evidence for an effect of visual perception or motor skill training on handwriting speed but no effect on handwriting legibility (Leung et al., 2016; Li et al., 2014; Poon et al., 2010).

**Sensorimotor Versus Therapeutic Practice Approaches**

Seven studies (4 Level I, 2 Level II, 1 Level III) with low risk of bias compared the relative effectiveness of sensorimotor versus therapeutic practice approaches to promote handwriting legibility outcomes. Sensorimotor approaches described in the studies consisted of combined activities that addressed visual perception, kinesthesia, in-hand manipulation, visual–motor integration, and biomechanical features of handwriting. Therapeutic practice approaches used paper-and-pencil activities with an emphasis on cognitive strategies such as self-evaluation techniques and the provision of performance feedback (Denton et al., 2006). Participants included children with and without identified handwriting difficulties.

Strong evidence from 3 Level I studies (Chang & Yu, 2014; Denton et al., 2006; Weintraub et al., 2009) and 1 Level II study (Jongmans et al., 2003, who also reported a Level III study; see Table A.1) supports therapeutic practice over sensorimotor approaches or usual classroom activities to improve handwriting legibility for children with handwriting difficulties. Moderate evidence from 3 studies supports the effectiveness of interventions to improve handwriting legibility for typically developing children (Howe et al., 2013, Level II; Kaiser et al., 2011, Level III; Zwicker & Hadwin, 2009, Level I).

**Interventions in Addition to Usual Classroom Activities**

Low evidence from 5 studies (2 Level I, 2 Level II, 1 Level III) with mixed results was found for combined programs provided in addition to usual classroom activities. An average of 9.8 hr of added instruction provided over 10 wk was provided; added instruction in one study occurred over an academic year and consisted of one to three additional lessons per week and 20 occupational therapy visits (Hape et al., 2014). An RCT with low risk of bias (Peterson & Nelson, 2003) and a Level II study (Lust & Donica, 2011) found significant positive results for the added intervention for typically developing participants. An RCT with unclear bias risk (Shimel et al., 2009) and a Level II study (Hape et al., 2014) found no differences between groups. A Level III study found significant improvements for a combined program for children with handwriting difficulties but used no comparison group (Roberts et al., 2010).

**Interventions in Place of Usual Classroom Activities**

Eight studies (6 Level II, 2 Level III) examined combined programs provided in place of usual classroom activities. An average of 16.5 hr of instruction provided over 10.6 wk was reported in five studies. Programs in three studies were conducted as curriculum throughout the academic year. All participants were typically developing.

Low evidence from 4 Level II studies (Case-Smith et al., 2014; Donica, 2015; Pfeiffer et al., 2015; Roberts et al., 2014) and 2 Level III studies (Case-Smith et al., 2011, 2012) supports combined programs over usual classroom activities. A confounding factor in these comparisons is incomplete descriptions of the curriculums replaced by the combined programs.

A Level II study found no differences after implementation of a manualized combined program compared with a manualized therapeutic practice–oriented program (Salls et al., 2013). Another Level II study showed significant improvement from use of teacher-designed instruction over a manualized combined program (Schneck et al., 2012).

**Discussion**

**Educational Participation**

The studies in this review addressed a variety of interventions to enhance educational participation. Yoga was found to be an effective activity-based intervention to improve classroom communication and engagement in school. Sensory-based interventions and environmental supports that address identified sensory-related issues have been used to
support participation in school settings (Dunn, 2013; Roley et al., 2015); weighted vests are used to improve attention, on-task behaviors, and staying seated (Hodgetts et al., 2011), and stability balls are provided as an alternative seating option to improve in-seat and on-task behavior (Fedewa & Erwin, 2011; Schilling et al., 2003). The evidence does not support the use of either intervention, however; standard chairs were found to be more effective than stability balls in the classroom, and weighted vests to increase educational participation for children with ASD were not found to be effective.

**Literacy Participation**

The strength of evidence is moderate supporting the effectiveness of activity-based interventions to support creative engagement in literacy and involve parents and peers in enhancing literacy participation. The activity-based interventions described in the 13 included articles were mainly carried out by teachers and reading specialists; only one was carried out by occupational therapists. The role of occupational therapy in literacy and the literature remains focused more on handwriting interventions and prerequisite skills for reading than on reading as an occupation and literacy participation (Grajo et al., 2016). Although the interventions in included studies were found to enhance literacy participation, not all interventions directly addressed reading as a skill (e.g., language-based skills needed for reading).

Our review revealed little evidence regarding explicit use of computer-based and assistive technologies to enhance literacy participation. The searches located 28 studies that used computer-based and assistive technologies (e.g., tablets, computer games, interactive books) as the primary method of intervention delivery, but these studies were excluded because they did not meet the outcomes and inclusion criteria for this systematic review. Twenty-three studies used computer- and technology-based programs to enhance prerequisite phonological processing, working memory, gross motor, visual–perceptual, and morphological skills for reading, which are critical for literacy participation, but these studies did not measure outcomes at the participation level (e.g., attitudes toward reading, reading and writing frequency, perception of mastery and competence toward literacy engagement).

When integrating activity-based interventions to promote literacy participation, occupational therapy practitioners should consider duration of intervention, level and quality of parent involvement, and support of peers of a variety of ages (i.e., cross-age rather than same-age peers). In addition, practitioners should use standardized measures of attitudes toward reading, reading preferences, and literacy-related behavior to measure self-concept related to literacy and outcomes of intervention (Grajo et al., 2016). Moreover, development of more occupation-centered assessments to measure literacy participation is needed.

**Handwriting**

This review found moderate evidence to support interventions to address handwriting legibility outcomes, including therapeutic practice, cognitive strategies such as self-evaluation techniques, and the provision of performance feedback. Therapeutic practice is an evidence-based approach to improve handwriting legibility. In contrast, the evidence indicates that sensorimotor handwriting interventions that address isolated component skills, such as visual perception, kinesthesia, in-hand manipulation, visual–motor integration, or biomechanical features of handwriting, have no effect on handwriting legibility.

Because of low strength of evidence, no definitive recommendation can be made concerning the effectiveness of handwriting programs with combined sensorimotor and therapeutic practice approaches for children either with or without identified handwriting difficulties. Whether these programs as a group have added benefit over usual classroom activities for typical writers cannot be determined without deeper examination of what constitutes usual classroom activities. Therefore, occupational therapy practitioners should be cautious when recommending additional instruction time using combined programs and should carefully evaluate the effectiveness of handwriting programs already in place before recommending combined programs as an alternative or for curriculum adoption.
Limitations
This systematic review presents a selected set of three themes—educational participation, literacy participation, and handwriting—to describe the effectiveness of interventions within the scope of occupational therapy to enhance literacy participation. Findings on themes related to social participation in schools, engagement in physical activity, life skills and employment, driver education, after-school programs, active commuting to school, and learning outcomes as they relate to school participation were not included.

Common limitations of the studies included in this review were small sample sizes, lack of random sampling, and lack of a control group. We included only research at Levels I through III; several Level IV studies were excluded that might have provided some preliminary evidence on the effectiveness of educational participation interventions. We also searched a limited number of databases and included only articles published in English.

Last, this review did not focus on interventions performed mainly by occupational therapy practitioners, but rather on activity-based interventions that are within the scope of occupational therapy. It may be hard to determine the generalizability of direct application of the interventions in these studies to school-based and pediatric occupational therapy practice.

Implications for Occupational Therapy Practice and Research
The findings of this review support the following recommendations for occupational therapy practice and research:

- Caution must be used in generalizing the use of stability balls and weighted vests to enhance educational participation in classrooms.
- Interventions that use choice, creative engagement, collaboration with parents, and support by cross-age peers show promise in enhancing children’s attitudes toward literacy and participation in literacy activities.
- Isolated skills training to address prerequisite skills for handwriting does not translate to improved handwriting performance. The use of prerequisite skills in interventions must be directly tied to handwriting tasks.
- More rigorous research is needed to support the effectiveness of interventions and to develop occupation-focused measures of educational participation.

References


*Indicates studies included in the systematic review.


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### Table A.1. Evidence Table for the Systematic Review of Interventions to Improve Children's Academic Participation

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Level of Evidence/Study Design/Participants/Inclusion Criteria</th>
<th>Intervention and Control</th>
<th>Outcome Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Educational Participation</strong></td>
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</tbody>
</table>
| Burgoyne & Ketcham (2015) | Level III  
N = 19  
Inclusion Criteria: 2nd graders in 1 classroom | **Intervention**  
Stability balls for all 2nd graders during regular classroom activities  
Control: No control | - On-task behavior: focus on activity and following classroom rules  
- Effort active and willing participation (e.g., raising hand for turn)  
- Interaction intensity | On-task behaviors significantly increased while students used stability balls. |
| Butzer et al. (2015) | Level III  
Pretest-posttest pilot  
N = 36 (2nd graders, n = 18, 11 girls; 3rd graders, n = 18, 9 girls)  
Inclusion Criteria: 2nd- and 3rd-grade students at an elementary school in Maine, parental consent | **Intervention**  
Yoga4 Classroom, consisting of breathing and physical exercises, postures, and meditation and relaxation techniques delivered during regular class time, 30 min 1×/wk for 10 wk  
Control: No control | - Attention Network Test  
- Teacher survey of perceived behavior changes in social interaction in the classroom and on-task ability | Significant improvements were found in teacher-perceived social interaction, attention, and on-task academic performance.  
Attention Network Test data were not presented in this article. |
| Fedewa et al. (2015) | Level I  
RCT  
N = 16  
Intervention group, n = 8  
Control group, n = 8  
Inclusion Criteria: 2nd graders in 4 classrooms in a rural elementary school, parental consent | **Intervention**  
Use of stability balls throughout the school day  
Control: Use of standard classroom chairs throughout the school day | - Behavioral observation of randomly selected 2 boys and 2 girls from each classroom:  
- On-task behavior coding: group work with peers, interaction with teachers, independent seat work  
- On-task behavior calculations  
- Academic performance: math and literacy | The intervention group showed significantly increased interaction with teachers but no significant increases in on-task behavior or academic achievement.  
The control group exhibited significantly more time on task while doing independent work and work with peers. |
| Fedewa & Erwin (2011) | Level III  
Single-subject A-B continuous time series  
N = 8 (2 girls; age range = 9–11 yr)  
Inclusion Criteria: 5th graders in 4 classrooms; ADHD test scores ≥120 (92nd percentile) | **Intervention**  
Use of stability balls by all students throughout the day for 12 wk  
Control: No control | - Momentary time sampling during language arts, math, and social studies:  
  - Position on or off ball  
  - On- or off-task behavior  
  - % of in-seat or on-ball behavior  
  - % of on-task behavior | Time spent seated increased from 45% to 94% when seated on a ball. Average on-task time increased from 10% to 80% when seated on a ball. |

(Continued)
Table A.1. Evidence Table for the Systematic Review of Interventions to Improve Children’s Academic Participation (Cont.)

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Level of Evidence/Study Design/Participants/Inclusion Criteria</th>
<th>Intervention and Control</th>
<th>Outcome Measures</th>
<th>Results</th>
</tr>
</thead>
</table>
| Frank et al. (2017)  | Level I  
  RCT  
  N = 159 (74 girls; 53.3% 6th graders, 44.7% 9th graders; group ns NR) | Intervention  
  Transformative Life Skills, a manualized yoga-based program addressing stress, physical and emotional awareness, self-regulation, and healthy relationships, delivered in homeroom classes by instructors actively engaged in responsive discussions, 12 sessions total (15, 30, or 60 min each)  
  Control  
  No intervention; typical school day | School Bonding Scale: prosocial behavior and school functioning, Unexcused absences, English and math grades | The intervention group had significantly fewer unexcused absences and significantly higher levels of school engagement. English and math grades were not significantly different.  
Because of large effect sizes on outcomes, Transformative Life Skills is recommended as a school-based intervention in inner-city middle and high school settings to promote school engagement. |
| Hodgetts et al. (2011) | Level II  
  Single case (withdrawal), mixed methods  
  N = 10 (8 girls; M age = 5.9 yr) | Intervention  
  Weighted vests in 3 phases: (1) no vest, (2) vest with weight, and (3) vest without weight (Styrofoam balls)  
  Control  
  Phases 2 and 3 randomly assigned to control for observation bias | Time sitting in chair, Off-task behaviors (e.g., looking away, not participating in intended activity), Conners Rating Scale | Time sitting in chair (measured in 3 students) did not significantly improve.  
Attention to task and seated behavior did not significantly improve. |
| Servacki & Cook-Cottone (2012) | Level I  
  Systematic review  
  N = 12 studies | Intervention  
  Yoga programs delivered in school  
  Control  
  No treatment | Social engagement, Communication with teachers and peers, Attention and concentration, Time on task, Contribution to the class | 4 studies included children diagnosed with ASD, intellectual disability, specific learning disability, or emotional disturbance or with severe educational problems.  
No studies provided strong evidence, 7 provided low evidence, and 5 provided moderate evidence.  
Findings are inconclusive because of lack of methodological rigor, small sample sizes, intervention variability, and absence of systematic randomization.  
Significant improvements in communication and classroom contribution were found in children with learning disabilities and emotional and behavioral problems compared with a control group. (Continued) |
<table>
<thead>
<tr>
<th>Author/Year</th>
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<th>Intervention and Control</th>
<th>Outcome Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taylor et al. (2017)</td>
<td>Level I Systematic review N = 13 studies Inclusion Criteria Group design or single-case research design, ≥1 participant with ASD diagnosis, examined effects of weighted vest use on a dependent variable, published in peer-reviewed journal in previous 25 yr</td>
<td>Intervention Weighted vest (5%–10% of bodyweight) use by children with ASD in the classroom, described in 7 single-case design articles with 32 independent experiments or “studies” Control No treatment</td>
<td>Data Collection Methods Video footage, in vivo observation, momentary time sampling, whole-interval recording, stopwatch Targeted Behaviors and Outcomes • Percentage of intervals with appropriate in-seat behavior • Percentage of intervals engaging in off-task behavior • Duration of on-task behavior • Off-task behaviors • Percentage of intervals of engaged behavior • Percentage of intervals of stereotypic behavior • Problem behaviors • Weight of vest • Duration of vest wearing during activities</td>
<td>Eight of the 13 studies did not support the use of weighted vests. Five studies showed strong evidence for weighted vest use by children with ASD; however, according to What Works Clearinghouse criteria, the results of these studies do not meet criteria for an evidence-based practice because of the limited number of participants and limited geographic regions represented. The evidence is insufficient to support weighted vest use by children with ASD in the classroom.</td>
</tr>
<tr>
<td>Chong et al. (2014)</td>
<td>Level II Nonequivalent group N = 74 Intervention group, n = 35 (74% boys; M age = 5.6 yr) Control group, n = 39 (43% boys; M age = 5.9 yr) Inclusion Criteria Teacher-identified emerging problems in reading, spelling, or language</td>
<td>Intervention Literacy activity pullout sessions at preschool to help children with beginning reading through word recognition, one-to-one word correspondence, visual discrimination, and phonemic awareness and with developing writing skills, 10 individual 45-min sessions Control Regular classroom instruction and activities</td>
<td>• PPVT–4 • WJ III: Picture Vocabulary, Spelling, Story Recall, and Understanding Directions subtests • Strengths and Difficulties Questionnaire • Behavior Assessment for Children 2</td>
<td>On the PPVT, the intervention group made significantly higher gains (M gain = 11 mo) compared with the control group (M gain = 2 mo). Similarly, on the WJ III subtests, the intervention group made significantly higher gains (M gain = 11 mo) compared with the control group (M gain = 3 mo). No significant changes were found in receptive and expressive language. Significant improvement was shown in prosocial behavior, including attention, interpersonal relationships with peers, and adaptability. The intervention had significant positive effects on reading attitudes with medium to large effect sizes. No significant differences were found in receptive language skills.</td>
</tr>
<tr>
<td>Chow et al. (2018)</td>
<td>Level I RCT N = 90 (58% boys; M age = 7.2 yr) Intervention group, n = 31 Control group, n = 59 Inclusion Criteria 2nd graders</td>
<td>Intervention Creative literacy activities designed to foster discussion of creative topics related to textbook content, 2×/wk for 10 wk Control Traditional English curriculum, 2×/wk for 10 wk</td>
<td>• Reading Attitude Survey • PPVT–4 • Raven’s Standard Progressive Matrices</td>
<td>(Continued)</td>
</tr>
<tr>
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</table>
| Grajo & Candler (2016) | Level III  
1 group pretest–posttest  
N = 5 (4 boys; 2 1st graders, 1 2nd grader, 2 3rd graders)  
Inclusion Criteria  
≥1 yr of below-grade-level academic performance in reading based on teacher curricular and standardized assessments | Intervention  
Occupation and Participation Approach to Reading Intervention, an intervention for children with reading difficulties, delivered by occupational therapists in 90-min group and 60-min individual pullout sessions, 2×/wk for 8 wk | • Gray Oral Reading Test–5  
• Test of Word Reading Efficiency–2  
• Woodcock Reading Mastery Test–III  
• COPM  
• Inventory of Reading Occupations–Pediatric  
Control  
No control | No significant differences were found in reading scores. 
Significant differences were found in perceived reading performance and reading satisfaction. |
| Higgins et al. (2015) | Level I  
RCT  
N = 92 children (54% boys; M age = 5.7 yr)  
Intervention group, n = 47  
Control group, n = 45  
N = 7 teachers (5 intervention, 2 control)  
Inclusion Criteria  
All consenting teachers in primary school teaching Senior Infants classes | Intervention  
Literacy Lift-Off, a mainstream classroom intervention consisting of literacy activities that mirror the activities in a Reading Recovery lesson delivered by special education team members in collaboration with class teachers, 4 or 5 daily 10-min rotating sessions | • Reading Self-Concept Scale  
• Woodcock Reading Mastery Test–III  
Control  
Wait list | No significant differences were found in Letter Identification. 
The intervention group showed moderate significant increases in Word Identification, significant increases in Word Attack scores, and significant increases in self-concept. |
| Jordan et al. (2000) | Level II  
Nonrandomized controlled  
N = 248  
Intervention group, n = 177  
Control group, n = 71  
Inclusion Criteria  
Kindergarten students with reading scores in lowest quartile and their families | Intervention  
Project EASE, a program led by a trained parent educator designed to increase the frequency and quality of language interactions through book-centered activities and to give parents information about and opportunities for engagement in their children’s developing literacy abilities, 5 1-mo units over 1 yr | • Parent reading practices survey  
• PPVT–4  
• Comprehensive Assessment Program  
• Home literacy activities performed  
• Home literacy environment assessment  
Control  
Standard educational curriculum | Significant changes were found in language composite scores. 
No significant differences were found in home literacy activities or home literacy environment. |

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<tr>
<td>Jun et al. (2010)</td>
<td>Level I Meta-analysis N = 12 studies</td>
<td>Intervention Tutoring interventions Control No treatment; typical classroom instruction</td>
<td>• Colorado Student Assessment Program measure • Stanford Diagnostic Reading Test • Researcher-developed measures of writing quality, reading comprehension, and self-esteem</td>
<td>The overall weighted MES for the 12 studies was 0.26, a relatively low magnitude. Cross-age tutoring had the highest MES (1.05), followed by adult tutoring (0.70) and computer-based tutoring (0.19). The MES was highest for tutoring reading (0.92), followed by tutoring other literacy skills (0.73) and tutoring writing (0.17). The MESs for small (&lt;7 hr) and medium (8–15 hr) amounts of tutoring were 0.24 and 0.20, respectively. However, for longer durations of tutoring (≥16 hr), the MES was fairly high (0.66). The MES was highest for students in the 10th grade or higher (0.90), followed by 6th and 7th graders (0.60) and 8th and 9th graders (0.18). The MES was the highest for studies with ≤20 students (1.43). The MES was highest for high-quality studies (0.50), followed by low-quality (0.42) and medium-quality studies (0.22). No significant effects on reading comprehension or vocabulary were found. Both intervention groups read significantly more books and read significantly more frequently with parents than the control group.</td>
</tr>
<tr>
<td>Kim &amp; Guryan (2010)</td>
<td>Level I RCT N = 325</td>
<td>Intervention Children and parents in the family literacy group were invited to attend three 2-hr literacy events Intervention Group 1: Children received 10 self-selected books during summer vacation Intervention Group 2: Family literacy group in which children received 10 self-selected books and were invited with their parents to attend 3 summer literacy events (2 hr in length) Control No intervention</td>
<td>• Gates-MacGinitie Reading Test • Researcher-developed measures of text comprehensibility and book frequency</td>
<td>(Continued)</td>
</tr>
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</table>
| Lee (2014)         | Level II, Quasi-experimental, nonrandomized controlled, mixed methods, N = 105 (45% boys; M age = 9.0 yr) | Intervention: Peer-Assisted Learning Strategies program implemented in supplementary reading classes, 20 min 4×/wk for 8 wk Control: No intervention | • Standardized Korean reading test  
• Elementary Reading Attitude Survey  
• Student survey | A significant increase with a small effect size was found in reading attitude for recreational reading. No effect was found on academic reading.  
A significant increase with a small effect size in reading test scores was found. |
| Levin & Aram (2012)| Level II, Nonrandomized, quasi-experimental, N = 124 parent–child dyads (119 mothers, M age = 33.7 yr; 5 fathers, M age = 36.7 yr; 50 boys, 74 girls, M age = 5.4 yr; group n NR) | Intervention:  
Group 1: Parent-mediated coaching on storybook reading  
Group 2: Parent-mediated coaching on writing  
Group 3: Parent-mediated coaching on visuomotor skills training Control: No intervention | • Coding of videotaped interactions: category of dialogue and maternal behavior, graphophonic and printing mediation  
• Nonstandardized measures of letter naming, letter sounds, isolation of initial sounds of words, initial letter names, word recognition, word spelling  
• PPVT adapted to Hebrew (expressive and receptive vocabulary) | The storybook reading group outperformed all other groups on number of mother-initiated dialogues and enhanced dialogues but not on number of child-initiated dialogues using descriptive measures. In this group, dyadic reading increased substantially and significantly on all three characteristics from pretest to posttest.  
Coaching on reading had no effect on writing or visuomotor skills, and coaching on writing had an effect only on writing.  
Alphabetic skills showed increases on descriptive and nonstandardized measures in the writing group, whereas linguistic competencies unexpectedly were not enhanced in the storybook reading group.  
The intervention group scored significantly higher on reading and writing, sentence structure, written text, length of text, and spelling.  
No significant differences were found in content of information and handwriting scores or in reading attitude scores. |
| Saint-Laurent & Giasson (2005) | Level I, RCT, N = 108, Intervention group, n = 53 Control group, n = 55 | Intervention: Family literacy workshops addressing book reading and school success, importance of book reading, library visits, playing with letters, functional literacy, listening to reading, writing plays, and synthesis, 90 min 2×/mo for 9 workshops Control: Standard parental interaction at school | • Adapted Test of Phoneme Segmentation  
• Adapted CPA  
• Nonstandardized invented spelling test  
• Nonstandardized attitude toward reading questionnaire  
• Curricular reading and writing test  
• Parent questionnaire | (Continued) |
### Table A.1. Evidence Table for the Systematic Review of Interventions to Improve Children’s Academic Participation (Cont.)

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<tr>
<td><strong>Steiner (2014)</strong></td>
<td>Level II&lt;br&gt;2 groups, nonrandomized, mixed methods&lt;br&gt;&lt;br&gt;$N = 38$ (gender and age NR)&lt;br&gt;&lt;br&gt;Intervention group, $n = 19$ (53% African American, 28% Latino, 17% White)&lt;br&gt;&lt;br&gt;Control group, $n = 19$ (46% African American, 22% Latino, 23% White)&lt;br&gt;&lt;br&gt;Inclusion Criteria&lt;br&gt;Students in 2 classrooms</td>
<td><strong>Intervention</strong>&lt;br&gt;Parent intervention consisting of instruction in using effective read-aloud strategies and ways to engage their children in response to books and a selection of children’s books, delivered over 8 wk&lt;br&gt;&lt;br&gt;<strong>Control</strong>&lt;br&gt;Regular educational curriculum</td>
<td>- Parent interviews&lt;br&gt;- Reader response forms&lt;br&gt;- Frequency analysis of use of reading strategies&lt;br&gt;- DIBELS: Letter Naming, Phoneme Segmentation, and Nonsense Word Fluency tests&lt;br&gt;- CPA&lt;br&gt;- Developmental Reading Assessment</td>
<td>The intervention group showed an increase in descriptive frequency of storybook reading by parents and use of “school-like” literacy practices, including effective storybook reading strategies and talking about storybooks, compared with the control group. The intervention group showed significantly increased CPA scores but no significant differences in Developmental Reading Assessment and DIBELS scores.</td>
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<tr>
<td><strong>Sylva et al. (2008)</strong></td>
<td>Level I&lt;br&gt;<strong>RCT</strong>&lt;br&gt;$N = 104$&lt;br&gt;&lt;br&gt;Intervention group, $n = 58$&lt;br&gt;&lt;br&gt;Control group, $n = 46$&lt;br&gt;&lt;br&gt;Inclusion Criteria&lt;br&gt;Age 5–6 yr</td>
<td><strong>Intervention</strong>&lt;br&gt;SPOKES (Supporting Parents on Kids Education in Schools), a parent training program, 28 2.5-hr sessions&lt;br&gt;&lt;br&gt;<strong>Control</strong>&lt;br&gt;Access to a phone helpline</td>
<td>- British Ability Scales: single-word reading&lt;br&gt;- BPVS&lt;br&gt;- Marie Clay test battery of phonological awareness&lt;br&gt;- Parental Account of Children’s Symptoms&lt;br&gt;- Parent questionnaires</td>
<td>The intervention had a significant positive effect on single-word reading scores. No significant group differences were found in pre-post changes in BPVS scores, phonological awareness, or concepts about print. For the children with writing assessments, the intervention group had significantly better writing scores. Frequency of attending the literacy program sessions and whether a parent had attended the literacy intervention at least once or not at all were both positively related to parents’ use of reading strategies at posttest. Attending the behavior part of the program was modestly related to increased use of reading strategies. Scores on the Reynell measure were significantly higher for the intervention group compared with the control group. Reynell expressive language gains were also seen in the intervention group compared with the control group, but these gains were not significant. Although mean increases were mostly noted in language over time, paired-sample $t$ tests indicated that these differences were not significant.</td>
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<tr>
<td><strong>Ullery et al. (2014)</strong></td>
<td>Level II&lt;br&gt;1 group with matched control, nonrandomized, pretest–posttest&lt;br&gt;$N = 93$ (50.0% boys; $M$ age at enrollment = 15.4 mo, $M$ age after 3-yr intervention = 39.7 mo)&lt;br&gt;&lt;br&gt;Intervention group, $n = 47$&lt;br&gt;&lt;br&gt;Control group, $n = 46$&lt;br&gt;&lt;br&gt;Inclusion Criteria&lt;br&gt;Mild to moderate developmental delay, individualized family support plan, enrolled in school’s Linda Ray Intervention Program</td>
<td><strong>Intervention</strong>&lt;br&gt;Linda Ray Intervention Program, consisting of transportation every morning to early intervention services during summer months as a supplemental program, 5 hr/day, 5 days/wk for 10 wk, over 3 yr&lt;br&gt;&lt;br&gt;<strong>Control</strong>&lt;br&gt;Typical academic services</td>
<td>- Reynell Developmental Language Scales&lt;br&gt;- Nonstandardized book reading inventory&lt;br&gt;- Stony Brook Family Reading Survey home literacy assessment</td>
<td>(Continued)</td>
</tr>
<tr>
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<tr>
<td><strong>Handwriting</strong></td>
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</table>
| Case-Smith et al. (2011) | Level III 1 group pretest–posttest with 6-mo follow-up  
N = 17 (M age = 77.5 mo)  
Inclusion Criteria  
1st graders in 1 classroom (2 received special education), teacher agreement to participate | Intervention  
Write Start coteaching program, 45 min 2×/wk for 12 wk  
Control  
No control | • ETCH  
• MHA  
• WJ III: Writing Fluency and Writing Samples tests | Significant improvements over pretest results were found on all measures at posttest and 6-mo follow-up, with strong effect sizes. |
| Case-Smith et al. (2012) | Level III 1 group pretest–posttest with 6-mo follow-up  
N = 36 (M age = 77.4 mo)  
Inclusion Criteria  
1st graders in 2 classrooms (6 received special education) | Intervention  
Write Start coteaching program, 45 min 2×/wk for 12 wk  
Control  
No control | • ETCH  
• WJ III: Writing Fluency and Writing Samples tests | The single group was divided for analysis into 3 levels on the basis of pretest ETCH scores: low (n = 11), average (n = 15), and high (n = 10). Significant improvements over pretest results were found on all measures at posttest and 6-mo follow-up, with strong effect sizes. The low and average groups made significantly greater progress than the high group in lowercase legibility and approached significance for fluency. |
| Case-Smith et al. (2014) | Level II 2 groups nonrandomized comparison  
N = 135  
Intervention group, n = 77 (M age = 78.5 mo)  
Control group, n = 58 (M age = 79.1 mo)  
Inclusion Criteria  
1st graders from 8 classrooms | Intervention  
Write Start coteaching program, 45 min 2×/wk for 12 wk  
Control  
Standard instruction 3–4 days/wk | • ETCH  
• WJ III: Writing Fluency and Writing Samples tests | The intervention group was divided for analysis into 3 levels on the basis of pretest ETCH scores: low (n = 24), average (n = 34), and high (n = 19). Significant improvements were found for all measures in the intervention group compared with the control group. The low group made greater progress than the high group in legibility and speed, and the high and average groups scored higher than the low group in fluency. The computer-assisted group showed significant improvements in near point copy, mean pause time, and mean peak velocity. |
| Chang & Yu (2014)      | Level I RCT  
N = 42 (26 1st graders, 16 2nd graders; age range = 6 yr, 6 mo–8 yr, 7 mo)  
Intervention Group 1, n = 14  
Intervention Group 2, n = 14  
Control group, n = 14  
Inclusion Criteria  
Dysgraphia, no other condition | Intervention  
Group 1: Computer-assisted program of letter formation with focus on sequence, force, legibility, and speed, 45 min 2×/wk for 6 wk  
Group 2: Sensorimotor training (visual perception, visual–motor integration, haptic perception), no practice, 45 min 2×/wk for 6 wk  
Control  
Usual school lessons | • Elementary reading/writing test: writing from phonetics, dictation, and far point copy  
• Computerized handwriting movement analysis: peak velocity, pen tip force, and mean pause time per stroke |                                                                                                                                                                                                 |
Table A.1. Evidence Table for the Systematic Review of Interventions to Improve Children’s Academic Participation  (Cont.)

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<tbody>
<tr>
<td>Denton et al. (2006)</td>
<td>Level I 3-group RCT, N = 38 (M age = 9 yr)  intervention Group 1, n = 14, intervention Group 2, n = 15, control group, n = 9, inclusion criteria Age 6–12 yr, no identified need, THS score 1.5 SD below mean</td>
<td>Intervention  Group 1: Sensorimotor intervention consisting of visual perception, visual–motor integration, proprioception/kinesthesia, and in-hand manipulation activities individually or in small groups, 40 min 4×/wk for 5 wk (10 hr total)  Group 2: Therapeutic practice consisting of worksheets and writing with feedback individually or in small groups, 40 min 4×/wk for 5 wk (10 hr total)  Control  Normal classroom activities</td>
<td>• THS: letter legibility  • DTVP–2: visual perception  • Test of Manual Pointing: proprioception/kinesthesia  • In-Hand Manipulation test</td>
<td>All groups showed significant improvement in letter legibility. A significant difference was found between the sensorimotor and therapeutic practice intervention groups, with a decrease in scores for the sensorimotor group and an increase for the therapeutic practice group. All participants had poor sensorimotor skills at pretest. The sensorimotor group improved significantly compared with the control group in visual perception, with a nonsignificant trend for greater improvement in translation manipulation skills.</td>
</tr>
<tr>
<td>Donica (2015)</td>
<td>Level II Static group comparison, N = 59, intervention group, n = 40 (M age = 76.1 mo), control group, n = 19 (M age = 77.7 mo), inclusion criteria All students in private half-day kindergarten, successive K cohorts</td>
<td>Intervention  HWT kindergarten teacher’s guide, 15 min/day throughout K year, plus OT in classroom, 1×/wk  Control  Teacher-developed D’Nealian, no OT</td>
<td>THS–Revised: legibility</td>
<td>Significant improvements were found for the intervention group cohorts, separately (d = 0.81 and 1.03) and combined (d = 1.00).</td>
</tr>
<tr>
<td>Hape et al. (2014)</td>
<td>Level II Nonrandomized controlled clinical trial, N = 43 (M age = 6 yr), intervention group, n = 21, control group, n = 22, inclusion criteria 1st graders in 2 classrooms</td>
<td>Intervention  HWT first-grade curriculum guide with writers workshop implemented by teachers in the classroom, 1–3×/wk, plus OT support, 20 min 1×/wk for 20 sessions  Control  Writers workshop 4×/wk throughout academic year, standard school curriculum, no OT support</td>
<td>The Print Tool Blind</td>
<td>Both groups improved significantly over the academic year. No significant differences between groups were found at end of academic year, with strong effect sizes (HWT, d = 1.07; control, d = 0.66).</td>
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### Table A.1. Evidence Table for the Systematic Review of Interventions to Improve Children’s Academic Participation (Cont.)

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<tr>
<td>Howe et al. (2013)</td>
<td>Level II: Nonequivalent group pretest–posttest N = 72 (age range = 5.9–7.9 yr)</td>
<td>Intervention: Handwriting Club, consisting of HWT and handwriting games (e.g., Hangman) in groups of 8 children and 1 therapist, 45 min 2×/wk for 6 wk Group 1: Intensive practice group: 20 min of club used for grade-level curriculum and writing tasks, letter formation, and composition Group 2: Visual–perceptual motor group: 20 min of club used for activities from My Book of Letters and Numbers and My Book of Shapes</td>
<td>Outcome Measures: MHA: legibility and speed VMI</td>
<td>Positive findings for Handwriting Club participants were claimed but not statistically substantiated. Legibility scores showed an advantage approaching significance for the intensive practice group compared with the visual–perceptual motor group.</td>
</tr>
<tr>
<td>Jongmans et al. (2003), Study 1</td>
<td>Level III: Pretest–posttest N = 15 (dysgraphic, n = 8 [6 boys; M age = 7.9 yr]; not dysgraphic, n = 7 [6 boys; M age = 8.6 yr])</td>
<td>Intervention: Handwriting self-instruction method: Learn the letter, produce the letter, self-identify errors, repeat, use the letter in context, delivered 1:1 with teacher, 30 min 2×/wk for 18 lessons</td>
<td>Outcome Measures: BHK: Handwriting Quality and Handwriting Speed subtests</td>
<td>Descriptive analysis was reported, with no comparisons tested for significance. Mean quality increased for the dysgraphic participants and decreased for the nondysgraphic participants. Speed increased for both groups. Of the dysgraphic participants, 4 remained dysgraphic, 3 moved to ambiguous, and 1 moved to normal. Of the nondysgraphic participants, 1 moved downward to ambiguous and all others stayed the same. All groups showed significant pre–post improvement. Intervention group participants with dysgraphia showed significant improvements in handwriting quality compared with control group participants with dysgraphia. No significant differences were found in handwriting speed.</td>
</tr>
<tr>
<td>Jongmans et al. (2003), Study 2</td>
<td>Level II: Case control N = 60 (M age = 10.4 yr)</td>
<td>Intervention: Handwriting self-instruction method: Learn the letter, produce the letter, self-identify errors, repeat, use the letter in context, delivered in groups with feedback by peers over 6 mo</td>
<td>Outcome Measures: BHK: Handwriting Quality and Handwriting Speed subtests</td>
<td>No significant group differences were found. Positive findings for Handwriting Club participants were claimed but not statistically substantiated. Legibility scores showed an advantage approaching significance for the intensive practice group compared with the visual–perceptual motor group.</td>
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Table A.1. Evidence Table for the Systematic Review of Interventions to Improve Children’s Academic Participation (Cont.)

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<td>Kaiser et al. (2011)</td>
<td>Level III&lt;br&gt;Posttest comparison&lt;br&gt;&lt;br&gt;&lt;br&gt;&lt;br&gt;N = 42&lt;br&gt;Intervention group, n = 23 (15 girls; age range = 6.1–7.4 yr)&lt;br&gt;Control group, n = 19 (11 girls)&lt;br&gt;&lt;br&gt;Inclusion Criteria&lt;br&gt;1st graders in 3 classrooms, voluntary participation</td>
<td>Intervention&lt;br&gt;Regular handwriting program plus additional session addressing digital dexterity, meaningful context, letter modeling, practice, and self-evaluation, 45 min 2×/wk for 6 wk&lt;br&gt;Control&lt;br&gt;Regular handwriting program, 45 min 1×/wk for 6 wk</td>
<td>BHK (French version): Handwriting Quality and Handwriting Speed subtests</td>
<td>The intervention group showed significant improvements in quality and speed.</td>
</tr>
<tr>
<td>Leung et al. (2016)</td>
<td>Level I&lt;br&gt;RCT&lt;br&gt;N = 26&lt;br&gt;Intervention group, n = 13 (M age = 8.0 yr)&lt;br&gt;Control group, n = 13 (M age = 8.4 yr)&lt;br&gt;&lt;br&gt;Inclusion Criteria&lt;br&gt;Chinese grades Primary 1 or 2, score &lt;30th percentile on Handwriting Ability Checklist, no known impairments</td>
<td>Intervention&lt;br&gt;Combined training: 45 min of computerized visual perception and visual–motor integration training plus 30 min visual efficacy training in ocular motor skills using devices and a computer program, 1×/wk for 8 wk&lt;br&gt;Control&lt;br&gt;Perceptual motor only group: 45 min of computerized visual perception and visual–motor integration training plus 30 min placebo using devices, 1×/wk for 8 wk</td>
<td>• Test of Visual Perceptual Skills–Revised&lt;br&gt;• VMI–5&lt;br&gt;• Developmental Eye Movement Test&lt;br&gt;• Computerized handwriting assessment tool</td>
<td>The control group showed significant improvements in nonmotor visual perception skills compared with the intervention group. No gains were made by either group in visual–motor integration. The intervention group made significant gains in amplitude of ocular accommodation. Both groups improved significantly in handwriting speed, with no posttest differences between groups.</td>
</tr>
<tr>
<td>Li et al. (2014)</td>
<td>Level I&lt;br&gt;RCT&lt;br&gt;N = 83 (M age = 7.5 yr)&lt;br&gt;Intervention group, n = 42 (25 boys)&lt;br&gt;Control group, n = 41 (22 boys)&lt;br&gt;&lt;br&gt;Inclusion Criteria&lt;br&gt;2nd graders from 5 classrooms</td>
<td>Intervention&lt;br&gt;Sport stacking, 15 min 5 days/wk for 14 wk&lt;br&gt;Control&lt;br&gt;Supervised physical education activities</td>
<td>• Total correct letter formations from a 3-sentence sample&lt;br&gt;• Writing speed</td>
<td>All participants improved in writing speed, with an nonsignificant difference favoring the intervention group (p = .08, effect size = 0.32). No differences in number of correct letters formed were found in pre–post or posttest comparisons.</td>
</tr>
<tr>
<td>Author/Year</td>
<td>Level of Evidence/Study Design/Participants/Inclusion Criteria</td>
<td>Intervention and Control</td>
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<tr>
<td>Lust &amp; Donica (2011)</td>
<td>Level II Clinical control N = 32 (Mage = 55.4 mo)</td>
<td>Intervention: HWT—Get Set for School, 20 min 3×/wk for 47 sessions</td>
<td>• Learning Accomplishment Profile—3: Prewriting domain</td>
<td>Both groups improved significantly in Prewriting domain and Check Readiness scores, with higher scores for the intervention group at posttest.</td>
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<td>Intervention group, n = 17 (Mage = 55.4 mo)</td>
<td>Control: Regular Head Start program</td>
<td>• Check Readiness tool</td>
<td>No significant pre-post differences were found on the BOT–2, but the intervention group scored higher than the control group at posttest.</td>
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<td>Control group, n = 15 (Mage = 55.9 mo)</td>
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<td>• BOT–2: Fine Manual Control</td>
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<td>Inclusion Criteria Low socioeconomic status, enrolled in Head Start classroom, age 4–5 yr, no cognitive deficits, no physical deficits that would interfere with fine motor ability</td>
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<tr>
<td>Palsbo &amp; Hood-Szivek (2012)</td>
<td>Level III Pretest–posttest N = 18 (age range = 5–11 yr)</td>
<td>Intervention: Robot-assisted glyph formation with haptic technology device that adjusts the amount of mechanical assistance provided, 30 min (10 min review, 10 min glyph formation, 10 min workbook lesson), 3–5×/wk for 15–20 sessions</td>
<td>• Reduction in SD of the height-to-width ratio of each letter and number glyph</td>
<td>Nonsignificant improvements were found in variability in glyph height-to-width ratios and VMI Motor Control subtest scores.</td>
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<td></td>
<td>Inclusion Criteria Children with or without diagnoses (e.g., ADD, ADHD, ASD, pervasive developmental delay, intellectual disability, auditory processing disorder, deafness), illegible handwriting or legible with speed &lt;16th percentile, orientation to written language, single-handed utensil or tool manipulation, recognize all letters of the alphabet, speak English, follow instructions, able to work 20 min</td>
<td>Control: No control</td>
<td>• VMI: Motor Control subtest</td>
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<tr>
<td>Peterson &amp; Nelson (2003)</td>
<td>Level I RCT N = 59 (Mage = 7.1 yr)</td>
<td>Intervention: 1:1 or 1:2 instruction with biomechanical, sensorimotor, and teaching–learning principles, 30 min (5 min heavy work, 20 min learning letters, 5 min practice), 2×/wk for 10 wk</td>
<td>MHA Gain scores were higher for the intervention group, with a moderate effect size (0.378).</td>
<td>Space and line size form sub scores were significantly improved for the intervention group. No differences were found for speed.</td>
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<td>Intervention group, n = 30</td>
<td>Control: Usual program</td>
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<td>Control group, n = 29</td>
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<td></td>
<td>Inclusion Criteria Economically disadvantaged 1st graders</td>
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Table A.1. Evidence Table for the Systematic Review of Interventions to Improve Children's Academic Participation (Cont.)

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<th>Author/Year</th>
<th>Level of Evidence/Study Design/Participants/Inclusion Criteria</th>
<th>Intervention and Control</th>
<th>Outcome Measures</th>
<th>Results</th>
</tr>
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<tr>
<td>Pfeiffer et al. (2015)</td>
<td>Level II Nonrandomized controlled pretest–posttest $N = 207$</td>
<td>Intervention Size Matters handwriting program implemented in the classroom by teachers, 20 min 5 days/wk for 40 days</td>
<td>• THS–Revised: 9 subtests&lt;br&gt; • MHA: 12 subtests</td>
<td>Kindergartners in the intervention group made significant gains on 3/3 measures, and these gains were greater than those of kindergartners in the control group. First graders in the intervention group made significant gains on 9/12 measures and those in the control group on 4/12 measures. The intervention group made greater gains than the control group on 6/12 measures, with a decrease in speed. 2nd graders in the intervention group made significant gains on 9/12 measures and those in the control group on 1/12 measures. The intervention group made greater gains than the control group on 9/12 measures, with a decrease in speed. The intervention group showed significantly improved MVPT–R scores at posttest and follow-up, with a significant advantage over the control group at posttest. No differences in VMI scores were found for either group. The intervention group showed significantly improved paper time and in-air time at posttest and follow-up, with a significant advantage over the control group at posttest. No group differences were found in legibility. The intervention group showed a significant decrease in legibility at posttest and follow-up. Descriptive questionnaire results indicated a positive parent perspective on the intervention.</td>
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<td></td>
<td>Intervention group, $n = 104$ (K, $n = 27$; 1st, $n = 39$; 2nd, $n = 38$)</td>
<td>Control Standard instruction as determined by classroom teacher</td>
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<td>Control group, $n = 103$ (K, $n = 28$; 1st, $n = 35$; 2nd, $n = 40$)</td>
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<td>Inclusion Criteria Grade K–2 students from 12 classrooms in 2 school districts</td>
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<td>Poon et al. (2010)</td>
<td>Level I RCT with 1-mo follow-up $N = 26$</td>
<td>Intervention Home program of computerized games for form perception, spatial relationships, visual memory and sequence memory, figure ground, visual closure, eye–hand coordination, and fine motor control, 45 min 1×/wk for 8 sessions</td>
<td>• VMI&lt;br&gt; • MVPT–R&lt;br&gt; • Penmanship objective evaluation tool, in-air and on-paper time&lt;br&gt; • Teacher judgment of word legibility&lt;br&gt; • Parent questionnaire</td>
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<td></td>
<td>Intervention group, $n = 13$ ($M$ age = 6.6 yr)</td>
<td>Control No intervention</td>
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<td></td>
<td>Control group, $n = 13$ ($M$ age = 6.7 yr)</td>
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<td>Inclusion Criteria Chinese grade Primary 1; handwriting difficulties; age 6–7 yr; MVPT–R and VMI scores ≥1 SD below mean; no intellectual, physical, emotional, or self-control impairment</td>
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</table>
Table A.1. Evidence Table for the Systematic Review of Interventions to Improve Children’s Academic Participation (Cont.)

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<tr>
<th>Author/Year</th>
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<th>Outcome Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roberts et al. (2014)</td>
<td>Level II Repeated measures crossover N = 157 (M age = 6 yr, 2 mo) Intervention group, n = 77 Control group, n = 80 Inclusion Criteria Grade 1 students in Canada, no upper extremity impairment, no severe developmental learning problems, no known neurological impairment, no previous exposure to HWT or OT services</td>
<td>Intervention HWT kindergarten teacher’s guide and kindergarten resources, 20 min/day 5×/wk for 9 wk (approximately 800 min total) Control Teacher-designed instruction</td>
<td>MHA COPM</td>
<td>MHA form, spacing, alignment, sizing, and total scores improved significantly for the intervention group compared with the control group. Improvements in legibility and rate were not significant. COPM results showed significant improvement in reported perceived handwriting performance over time for the intervention group.</td>
</tr>
<tr>
<td>Roberts et al. (2010)</td>
<td>Level III 1 group repeated measures N = 32 (M age = 10.5 yr) Inclusion Criteria 4th–6th graders in general education; handwriting difficulty; no physical, cognitive, or behavioral concerns by teachers</td>
<td>Intervention Hand and arm activities (10 min), teaching and practice of letters using Loops and Other Groups program, and homework sheets (15–20 min), delivered in small groups (3–7) after school, 60 min 1×/wk for 7 wk Control No control</td>
<td>Three handwriting samples (copying, composition, alphabet samples) scored using the following: TOWL: Global Legibility HES: handwriting errors Speed: letters per minute Attitude scale: personal satisfaction with handwriting Parent and teacher reports</td>
<td>TOWL scores showed significant improvement at follow-up. HES scores improved significantly with the exception of word spacing in the copy task and letter spacing in the composition task. Speed showed significant improvements that did not continue to follow-up. The attitude scale indicated improved personal satisfaction at posttest and follow-up. Both groups improved on The Print Tool measures, with no significant differences between groups. Neither group improved on VMI measures, although a significant difference with a low effect size favored the HWT group over the Peterson group. Both groups improved on all MHA subscales except legibility, form, and spacing. No Group × Time interactions were found. (Continued)</td>
</tr>
<tr>
<td>Salls et al. (2013)</td>
<td>Level II 2 groups nonrandomized repeated measures N = 31 Intervention group, n = 14 (M age = 6.5 yr) Control group, n = 17 (M age = 6.6 yr) Inclusion Criteria First graders in 2 classrooms</td>
<td>Intervention Group 1: HWT: Developmental multisensory-based classroom instruction throughout academic year Group 2: Peterson Directed Handwriting Method: Cognitive approach to classroom instruction with directed practice throughout academic year Control No control</td>
<td>The Print Tool VMI MHA</td>
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</table>
Table A.1. Evidence Table for the Systematic Review of Interventions to Improve Children’s Academic Participation (Cont.)

<table>
<thead>
<tr>
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<th>Intervention and Control</th>
<th>Outcome Measures</th>
<th>Results</th>
</tr>
</thead>
</table>
| Schneck et al. (2012) | Level II 2 groups nonrandomized, pretest–posttest N = 147  
Intervention group, n = 81 (general education, n = 67; special education, n = 14)  
Control group, n = 66 (general education, n = 54; special education, n = 12)  
Inclusion Criteria 1st graders in 2 classrooms (1 intervention, 1 control) in 4 rural schools (total of 8 classrooms) | Intervention  
HWT, 15–20 min/day, plus OT consultation, 2×/mo, throughout school year  
Control  
Teacher-designed instruction throughout school year | MHA  
• ETCH–Cursive: lowercase letters, uppercase letters, total  
• Error Recognition and Grading Scale | General education students in the control group improved significantly in gain scores for form and alignment and in total, legibility, form, alignment, size, and spacing scores at posttest.  
Special education students showed no significant group differences in gain or posttest scores.  
Gain scores of children in general education did not differ from those of children in special education. |
| Shimel et al. (2009) | Level I RCT N = 50  
Intervention Group 1, n = 18  
Intervention Group 2, n = 17  
Control group, n = 15  
Inclusion Criteria 1st graders with no identified handwriting difficulty | Intervention  
Group 1: HWT: Cursive handwriting instruction in small groups (5–7), 10–15 min/day for 6 wk  
Group 2: Loops and Other Groups: Cursive handwriting instruction in small groups (5–7), 10–15 min/day for 6 wk  
Control  
Zaner-Bloser course during regular classroom instruction |  
• Kinesthetic Sensitivity Test: acuity, perception, and memory  
• ETCH  
• Teacher questionnaire | The control group showed significant improvement on all 3 ETCH–Cursive measures.  
The HWT group improved on uppercase and total scores. The Loops and Other Groups group improved on uppercase scores. No significant differences were found between groups.  
No significant differences were found in Error Recognition and Grading Scale scores.  
At posttest, all groups showed significant improvement of kinesthesia, with no significant difference in the magnitude of improvement among the groups.  
There was no significant improvement in handwriting legibility as measured by a standardized test in any of the groups, although teachers indicated improvement in handwriting legibility in the classroom setting for all groups.  
Teachers also reported maintenance of handwriting legibility 4 wk after posttest. |
| Sudsawad et al. (2002) | Level I RCT N = 45 (Mage = 6 yr, 11 mo)  
Intervention Group 1, n = 15  
Intervention Group 2, n = 15  
Control group, n = 15  
Inclusion Criteria 1st graders with kinesthetic deficit, teacher-identified handwriting difficulties, normal vision and hearing, full muscle range and good tone, normal attention span | Intervention  
Group 1: Kinesthetic training including runway task for kinesthetic acuity and pattern task for kinesthetic perception and memory, 30 min/day for 6 days  
Group 2: Handwriting practice including copy tasks and work booklets with verbal and visual feedback, 30 min/day for 6 days  
Control  
Usual classroom activities |  |  |
At posttest, both intervention groups improved significantly compared with the control group, as measured by the ETCH: letter legibility. Significant improvements occurred for the task-oriented approach, delivered in small groups, and the cognitive approach: alphabet warm-up, modeling, imitation, discussion, practice, and self-evaluation, 30 min 1×/wk for 10 wk, plus individual OT practice in different contexts (e.g., word games, greeting cards), 60 min 1×/wk for 8 wk.

All groups showed significant gains at 4-mo follow-up. No significant differences among groups were found in change scores.

1st graders in all groups improved significantly compared with the multisensory approach: chalkboard demonstration and copying, sky writing, sand writing, glitter glue, marker with worksheet, and paper copy, 30 min 1×/wk for 10 wk, plus individual OT practice in different contexts (e.g., word games, greeting cards), 60 min 1×/wk for 8 wk.

2nd graders in the cognitive group improved significantly compared with the control group in overall legibility. Significant gains were found for the control group.
### Table A.2. Risk-of-Bias Table for Included Intervention Studies

<table>
<thead>
<tr>
<th>Citation</th>
<th>Selection Bias</th>
<th>Performance Bias</th>
<th>Detection Bias</th>
<th>Attrition Bias</th>
<th>Reporting Bias</th>
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<td>Random Sequence Generation</td>
<td>Allocation Concealment</td>
<td>Blinding of Participants and Personnel</td>
<td>Blinding of Outcome Assessment: Self-Reported Outcomes</td>
<td>Blinding of Outcome Assessment: Objective Outcomes</td>
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<td>Educational Participation</td>
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<td>Burgoyne &amp; Ketcham (2015)</td>
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<td>Literacy Participation</td>
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Table A.2. Risk-of-Bias Table for Included Intervention Studies (Cont.)

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Table A.3. Risk-of-Bias Table for Included Systematic Reviews

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