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Word Problem Solving Interventions for English Learners at Elementary Grade Levels: A Review of the Literature

Jing Wang*
University of Nebraska-Lincoln

Norma Lopez-Reyna
Sunyoung Kim
University of Illinois at Chicago

Mathematical word problems present various challenges for students, including English learners. Research on word problem-solving interventions for elementary English learners with or at risk for mathematics disabilities/difficulties was reviewed. A systematic search of studies conducted between 2012 and 2022 yielded a total of 14 research studies that met all of the preestablished criteria. Results of this review indicate that more than half of the studies implemented interventions with a focus on text comprehension. Implications and directions for future research and practice are presented.

Keywords: **English learners/English language learners, word problems intervention, elementary grade levels, learning disabilities, mathematics difficulties**

Introduction

The math achievement gaps between English learners (ELs) and native English speakers remain wide. Recent data from the National Assessment of Educational Progress (NAEP; National Center for Education Statistics, 2019) revealed that during the academic years of 2017-2019, the average math score of ELs was significantly lower than that of their non-EL counterparts at both the fourth and eighth-grade levels. Moreover, the data indicated a concerning lack of improvement in the math performance of ELs compared to a decade ago (NAEP, 2019). ELs with disabilities represent nearly one-third of students with disabilities in the United States and are increasingly present in contemporary mathematic classrooms (Cho et al., 2020; Trainor et al., 2016). As such, considering the unsatisfactory math outcomes in ELs, enhancing their math achievement has become a pressing issue.

In the elementary grades, acquiring basic math skills and math word problem-solving (WPS) skills are important for developing a solid foundation in mathematics. Students who become proficient in WPS are more likely to achieve and sustain academic success, develop positive peer relationships, and pursue higher-paying jobs after high school graduation (Fuchs et al., 2021; Hein et al., 2013; Powell et al., 2022; Takeuchi, 2016). Recognizing the pivotal role of WPS in the math curriculum, the National Council of Teachers of Mathematics (NCTM, 2007) has emphasized the need for all instructional programs to prepare school-aged students to be adept problem solvers. The Common Core State Standards for Mathematics (CCSSM; 2020)

*Please send correspondence to: Jing Wang, Department of Special Education & Communication Disorders, University of Nebraska-Lincoln, 301 Barkley Memorial Center, Lincoln, NE 68503, USA, Email: jwang99@unl.edu.

have likewise underscored the importance of implementing a rigorous math curriculum to enhance students' WPS ability. Unfortunately, many students with math disabilities/difficulties experience considerable challenges in solving word problems (Kong et al., 2021; Powell et al., 2019). Particularly, ELs with or at risk for math difficulties or disabilities may encounter more significant obstacles throughout the entire WPS process (Beal et al., 2010).

Mathematical word problems are commonly presented in a non-mathematical language, necessitating a meticulous series of steps for students to successfully arrive at a solution (Chapman, 2006). The step-by-step solution path typically begins with reading and comprehending the word problem text, continues with identifying key information, then constructing mathematical equations, and ends with performing arithmetic calculations to solve the problem (Polya, 1945; Salado et al., 2019). In fact, ELs often encounter obstacles at the outset during the text comprehension step due to their limited proficiency in the English language, and this hurdle may potentially impact their performance in the subsequent steps (Halle, 2012). For example, Martiniello (2008) investigated why ELs persistently remain in the lowest-scoring group on state high-stakes tests. The findings revealed that linguistic complexity (e.g., syntactic features, problem length) was the most significant determinant for WPS performance in ELs. Swanson et al. (2019) reported similar findings and determined that English vocabulary and reading comprehension highly correlate with ELs' WPS accuracy.

In addition, when taking into the typical characteristics of students identified with learning disabilities, it becomes apparent that ELs with or at risk for math difficulties or disabilities may grapple with additional challenges in areas such as working memory, mathematical reasoning, and/or computation (Freeman & Crawford, 2008; Fuchs et al., 2016; Swanson et al., 2015). Undoubtedly, ELs with or at risk for math difficulties or disabilities confront significant impediments when attempting to solve mathematical word problems. This is not a mere issue of proficiency in solving word problems. Instead, it is an intricate intertwining of language proficiency, cognitive process, and mathematical understanding. As such, identifying effective interventions to support the development of WPS skills among ELs with or at risk for math difficulties or disabilities is of critical importance.

A growing number of research studies have utilized different strategies to explore effective math interventions in WPS for ELs with or at risk for math difficulties or disabilities. To examine the effectiveness of these intervention studies, researchers have conducted a couple of meta-analyses to determine the degree of effectiveness (i.e., small, moderate, or large). For instance, Baker et al. (2018) presented a meta-analysis of ten single-case research design studies evaluating the effects of interventions for ELs who were identified as at-risk or with a learning disability. Studies included in their review were published between 2000 and 2015, with four studies focused on mathematics, five studies on reading, and one study on writing and behavior. The four math studies (Orosco, 2013, 2014a, 2014b; Orosco et al., 2013) used the same type of strategies (*Dynamic Strategic Math, DSM*) that focused on teaching WPS to ELs at risk for math disability. Participants included in these four studies showed improved WPS skills, and the intervention effect size was large.

More recently, Lei and colleagues (2020) conducted a meta-analysis of 10 single-case design studies published spanning from 2012 to 2019, with a focus on WPS interventions for K-12 students with learning disabilities and mathematics difficulties Each reviewed study included at least one EL identified with or at risk for learning disabilities or mathematics difficulties. The authors initially examined whether participant characteristics such as gender, native language, grade level, and disability status influenced intervention effectiveness. The results indicated that all variables, except 'gender,' had significant effects on the intervention results. The authors also explored whether intervention characteristics such as word problem types, instructional focus, or instructional time, affected intervention effectiveness. Based on their findings, Lei et al. (2020) concluded that interventions focused on fraction word problems yielded a larger effect size in reference to interventions that used whole-number word problems. Additionally, the authors reported that instruction targeted solely at mathematics produced a higher effect size than instruction that included reading comprehension and mathematics (Lei et al., 2020).

The prior two meta-analyses provided information on the effectiveness of WPS interventions for at-risk ELs and how various participant and intervention characteristics impact intervention effect sizes. This information can help researchers and practitioners modify intervention designs to achieve more favorable outcomes. However, to date, no descriptive synthesis has explicitly focused on synthesizing the types of instruction and instruction components included in each published literature on WPS intervention for elementary ELs with or at risk for math difficulties or disabilities. Thus, the purpose of the current study is to conduct a comprehensive literature review of WPS interventions for ELs with or at risk for math difficulties or disabilities, with a focus on identifying effective intervention strategies and instructional components that have promoted the WPS achievement of ELs with or at risk for math difficulties or disabilities. The results from this literature review may support researchers and practitioners in understanding evidence-based intervention practices in mathematics WPS. In addition, this review aims to provide practitioners with a collection of WPS intervention strategies or packages that they can choose from to best serve their ELs with or at risk for math difficulties or disabilities at the elementary level.

The following research questions guided the review:

1. What were the language and disability characteristics of the participants?
2. How studies identified students with or at risk for math difficulties or disabilities?
3. What instructional strategies/packages were used within the word problem-solving interventions?

Methods

Inclusion Criteria

In this review, a search procedure was undertaken based on five criteria: First, studies included participants with a diagnosed learning disability in mathematics or described as at-risk for math disability(ies) or math difficulty(ies). Second, each

study implemented an intervention focusing on math WPS performance. Third, at least one participant of the total participants recruited in the studies was identified as English Language Learners (ELLs) or ELs. Fourth, participants attended elementary school (age 5-12 years old) at the time of being included in the studies. Finally, studies outside of the U.S. were excluded because of the potential differences in education standards, legislation, and measurement.

Literature Search Procedures

A computer-assisted search of research articles was conducted using the following databases: PsycINFO, ERIC, Education Research Complete and Academic Search Complete, and a snowballing technique of hand-searching additional articles from the reference lists of journal articles. The search was limited to peer-reviewed research articles written in English and published from 2012 to 2022. The target participants in the studies were restricted to the context of elementary education. Four sets of search terms were created: (a) English learner OR English language learner OR Second language learner; (b) math* OR word problem OR word problem solving OR story problem OR arithmetic word problem; (c) learning disability OR learning difficulty OR at risk OR struggling OR special needs OR math difficulty OR math disability; and (d) intervention OR instruction OR program OR practice OR evidence-based intervention OR evidence-based instruction OR evidence-based practice. The electronic search with terms from all four levels yielded 413 results. In addition, the manual searching process yielded five additional articles published from 2012 to 2022 from the following journals: *Learning Disability Quality, Journal of Learning Disability, Learning Disabilities Research & Practice, Exceptional Children*, and *Journal of Special Education*. These five journals were the leading journals in the field of special education and learning disability. After reviewing those articles based on the inclusion criteria, 14 studies were considered eligible to be included in the current study. Figure 1 shows the summary of search procedures.

To ensure the reliability of search results, the first author reviewed all 413 articles, and the second author randomly reviewed half of the total articles ($n = 207$). As a result, the authors reached 100% agreement on the search results. The authors calculated the reliability using the formula: total number of agreements/ (total number of agreements + total number of disagreements) (Kennedy, 2005). The first author then independently reviewed the reference lists of the 12 identified articles and found an additional two articles to be eligible. The second author reviewed these two articles and agreed with the first author's evaluation result. Again, the first and second authors reached 100% agreement on this manual search outcome. A total of 14 articles, therefore, were included in this review.

Data Analysis

As a first step, the two authors independently reviewed the 14 studies and manually coded the studies using two sets of variables. The first set of variables focused on extracting participant demographic information (e.g., grade level, disability diagnosis). Figure 2 presents participant demographic characteristics. The second set of variables indicates each study's intervention characteristics (e.g., intervention setting, word problem type). Table 1 reports information on study characteristics. Ac-

cordingly, two sets of reliability data were obtained by determining the total number of agreements plus disagreements divided by the total number of agreements (Kennedy, 2005). As a result, the authors reached 100% on data coding. Further, the authors synthesized each study with a brief description of the identified strategies and intervention practices. Finally, the authors presented information about intervention outcomes, including effect size data, for those studies where such information was reported.

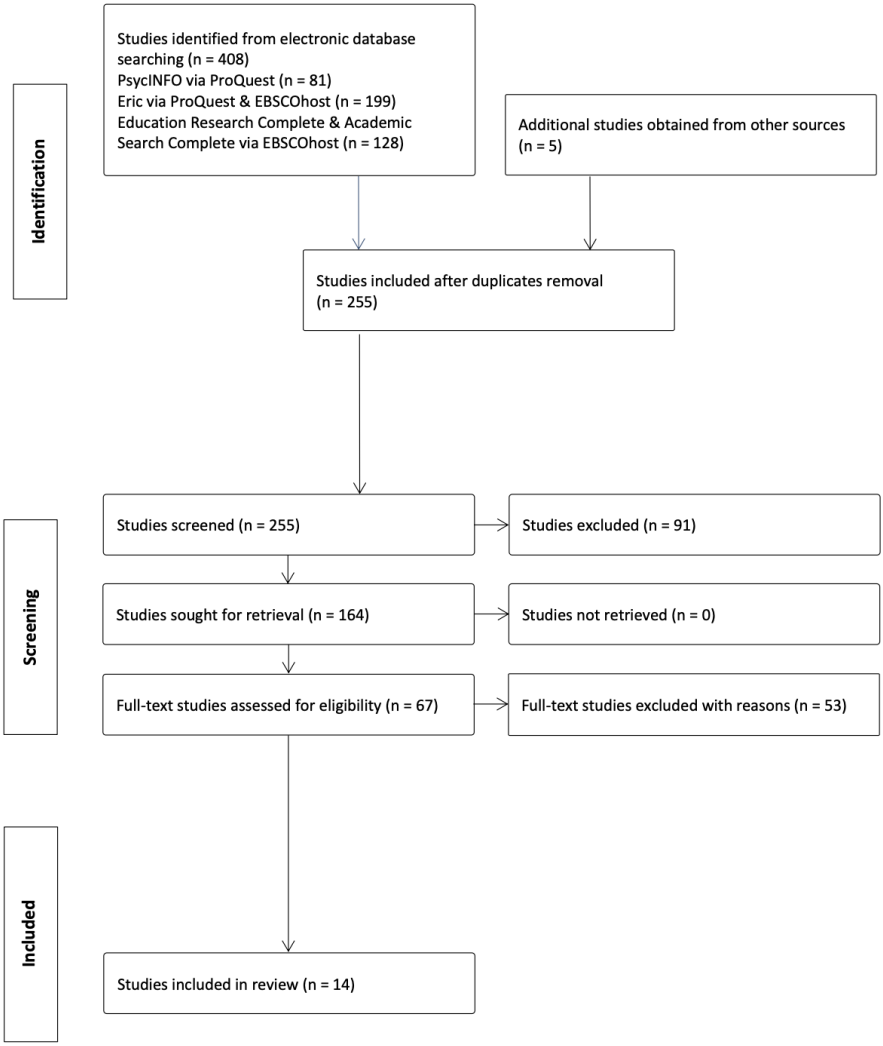

Figure 1. **Procedures of the literature search to identify eligible studies**

Table 1. ***Intervention Study Characteristics***

Citation	# of Participant	Grade Level	Participant Race/ Ethnicity	Agent Race/ Ethnicity	Setting	Agent	Intervention Duration & Frequency & Total Sessions/Weeks	Research Design	Problem Type
Driver & Powell (2017)	9	3rd	Hispanic & AA	Caucasian & AA	Small group	Undergraduate & doctoral student	20-25 mins, 3 times/ week, 10 weeks	Quasi-experimental design	One-step, addition & subtraction
Jitendra et al. (2013)	135	3rd	Hispanic, AA, Caucasian, AI, Asian, & Biracial	Caucasian, AA, Asian American, & Biracial	Small group	Tutors from the community	30 mins, 5 times/week, 12 weeks	Pretest–intervention–posttest–retention test	One- and two-step, addition & subtraction
Kim et al. (2015)	3	4th	Chinese & Korean	Korean	One-on-one	Researcher	25-30 mins, 3 to 4 times/week, 19-27 sessions	Multiple probe across participants design	Multi-step, fraction
Kingsdorf & Krawec (2016)	10	3rd	Hispanic & Non-Hispanic	Hispanic	Whole class	Classroom teacher	School math period, 3 times/week, total sessions/weeks NR	Multiple baseline across behaviors design	One-step, addition, subtraction, multiplication, & division
Kong & Swanson (2018)	9	3rd	Hispanic& Indonesian	NR	Small group	Graduate student	30 mins, 3 times/week, 8 weeks	Changing criterion & multiple baseline across subjects design	One- and two-step, addition & subtraction
Moran et al. (2014)	72	3rd	AA, Asian, Caucasian, Hispanic, & Other	NR	Small group	Tutors	25 - 30 mins, 2 times/ week, 10 weeks	Pretest–posttest experimental design	One-step, addition & subtraction

Table 1. ***Intervention Study Characteristics (continued)***

Orosco (2013)	6	2nd	Hispanic	NR	One-on-one	Classroom teacher & Researcher	20 - 25 mins, 3 times/ week, 5 weeks	Changing criterion & multiple baseline across subjects design	One-step, addition & subtraction
Orosco et al. (2013)	6	2nd	Hispanic	NR	One-on-one	Classroom teacher & Researcher	20 - 25 mins, 3 times/ week, 5 weeks	Multiple baseline across participants design	One-step, addition & subtraction
Orosco (2014a)	6	3rd	Hispanic	NR	One-on-one	Classroom teacher & Researcher	20 - 25 mins, 3 times/ week, 5 weeks	Changing criterion & multiple baseline across subjects design	One-step, addition & subtraction
Orosco (2014b)	6	3rd	Hispanic	NR	One-on-one	Homeroom teacher	20 - 25 mins, 3 times/ week, 5 weeks	Changing criterion & multiple baseline across subjects design	One-step, addition & subtraction
Orosco & Abdulrahim (2018)	78	3rd	Hispanic	NR	Small group	Tutors	30 mins, 2 times/week, 10 weeks	Group experimental	One-step, addition & subtraction
Sharp & Dennis (2017)	3	4th	Hispanic	NP	One-on-one	Researcher	30 minutes, every other day, 18 sessions	Multiple probe across participants design	Fraction compare & order
Swanson et al. (2019)	142	3rd	Hispanic & Non-Hispanic	NP	Small group	Tutors	30 minutes, 2 times/ week, 10 weeks	Randomized control design	One-step, addition & subtraction
Xin et al. (2020)	4	3rd	Hispanic & AA	NA	One-on-one	Computer	20-30 minutes, 4 times/week, 22-36 sessions	Multiple probe design	One-step, addition & subtraction

Note. AA = African American, AI =American Indian, ID = intellectual disability, NA = not apply, NP = not reported, SLD = specific learning disability.

Results

Participant Characteristics

The 14 studies discussed in this review include students from elementary school settings who received word problem-solving interventions. The total number of students included in this review was 490, of which 308 students were designated as ELLs or ELs. Two studies focused on second-grade students (n = 12, 2.4%), ten studies centered on third-grade students (n = 472, 96.3%), and two studies investigated the implementation of word problem-solving interventions on fourth-grade students (n = 6, 1.2%). Regarding racial/ethnic background, the majority of the participants were Hispanic (n = 318, 65%), 8% were African American (n = 40), 2% were Asian (n = 10), 8% were Caucasian (n = 37), 0.2% were Indonesian (n = 1), 0.2% were Biracial (n = 1), 1% were American Indian (n = 7), and 15% of the total participants' race/ethnicity were unknown. Figure 2 presents the demographic information for the participants in the studies reviewed.

Participant characteristics (e.g., language and disability) were not reported uniformly across all studies. For participants who use a language other than English as their native language, eight studies described these students as "English language learner", four studies used the term "English learners" to define students whose home language is not English, and participants included in the remaining two studies were referred to as "English for speakers of other languages". Moreover, during the intervention, 12 studies implemented English as the language of instruction, whereas two studies employed Spanish as the intervention language. Likewise, the types of disabilities presented in the studies varied. Four studies considered participants as at risk of mathematics difficulty, one study included low-performing or low-achieving participants who demonstrated significant difficulties in mathematics, six studies included participants who were at risk for math disabilities, and two studies included participants who identified with a specific learning disability. Table 2 presents participants' language and disability characteristics across the reviewed studies.

		Single Case Design (n = 62)	Group Design (n = 428)
Grade			
	2nd	12	0
	3rd	44	434
	4th	6	0
Gender			
	Male	28	213
	Female	34	215
Language			
	Native English Speaker	0	103
	English Learner	59	174
	Not Reported	3	151
Race/ Ethnicity			
	African American	2	38
	Asian	3	7
	Caucasian	0	37
	Hispanic	53	265
	Indonesian	1	0
	Biracial	0	1
	American Indian	0	7
	Not Reported	0	72
Diagnosis			
	At-risk for Math Disabilities/Difficulties	59	425
	Specific Learning Disability	5	0
	Intellectual Disability	1	0

Figure 2. **Participant Demographic Characteristics**

Table 2. English language status and MD status

Reference	English Language Status	Disability Status	Cutoff Scores
Driver & Powell (2017)	ELL	at risk of mathematics difficulty	< 25th percentile
Jitendra et al. (2013)	ELL	at risk of mathematics difficulty	< 40th percentile
Kim et al. (2015)	EL	low-performing/ achieving" and "demonstrate significant math difficulties	< 25th percentile
Kingsdorf & Krawec (2016)	ESOL	at-risk, SLD	NR
Kong & Swanson (2018)	EL	at risk of mathematics disabilities	< 25th percentile
Moran et al. (2014)	ELL	at risk for mathematics disabilities	< 25th percentile
Orosco (2013)	ELL	at risk for math disabilities	< 25th percentile
Orosco et al. (2013)	ELL	at risk for math failure/ math disability	< = 35th percentile
Orosco (2014a)	ELL	at risk for math disabilities	< 25th percentile
Orosco (2014b)	ELL	at risk for math disabilities	< 25th percentile
Orosco & Abdulrahim (2018)	EL	at risk of mathematics learning difficulties	< 25th percentile
Sharp & Dennis (2017)	ESOL	SLD	NA
Swanson et al. (2019)	ELL	at risk for math difficulties	< 35th percentile
Xin et al. (2020)	EL	learning difficulties in mathematics	< 30th percentile

Note. ELL = English Language learner, EL = English Leaner, ESOL = English for Speakers of Other Languages, SLD = specific learning disability, NA = not apply, NR = not reported.

In addition to the variation of language and disability characteristics, the studies included in this review applied distinct criteria for identifying students with or at risk for math difficulties or disabilities. Specifically, eight studies included students

who performed in the lower 25th percentile on a norm-referenced math test (e.g., *Woodcock-Johnson IV Test of Achievement*), one study included students who scored below the 30th percentile on a norm-referenced measure (i.e., *Stanford Achievement Test*), two studies set the criteria as performing below or at the 35th percentile on a standardized measure (e.g., a normative calculation measure), one study set the criteria as performing below the 40th percentile on a districtwide standardized test (i.e., *Measures of Academic Progress*), and one study did not report information regarding the identification criteria. Table 2 depicts the identification criteria of participants with or at risk for math difficulties or disabilities.

Intervention Settings

The intervention was implemented in two types of settings. School settings accounted for 93% of studies (n =13), and community setting was only used in 7% (n = 1) of the identified studies (Kim et al., 2015). The length of interventions varied from 5 weeks to 12 weeks, with an average of 20-30 minutes duration per session. Intervention frequency ranged from 2 times per week to 5 times per week.

Research Designs

Of the 14 studies discussed in this review, nine implemented a single case research design, and five used a group comparison design. Within the nine single case design studies, four used a combined criterion changing design and multiple baseline design across subjects, one adopted a multiple baseline design across behaviors, one utilized a multiple baseline design across subjects, and three used a multiple probe design across subjects. In the five group comparison design studies, one used an exploratory quasi-experimental design, two used a group experimental design, one applied a pretest-intervention-posttest-retention test design, and one employed a pretest-posttest comparison group design.

Intervention Strategies

In the literature on mathematics problem-solving interventions for ELLs or ELs with or at risk for math difficulties or disabilities, researchers have utilized several intervention strategies/instructional approaches to explore the effectiveness of the intervention. This review classified these strategies into seven broad categories based on the main instructional focus of each intervention study. We presented each category with the studies that fell into that category. Table 1 displays the key features of the included studies.

Comprehension strategy. Five studies examined a comprehension strategy for enhancing WPS skills. Of the five studies, four (Orosco, 2013, 2014a, 2014b; Orosco et al., 2013) used the same strategies (*Dynamic Strategic Math, DSM*) and examined its effectiveness on Latino ELLs at risk for math difficulties or disabilities. Orosco (2013, 2014a) conducted the intervention in Spanish, while Orosco et al. (2013) and Orosco (2014b) delivered the intervention in English.

In each of these four studies, the intervention was implemented in three instructional phases: (a) pre-teach math concepts and vocabulary, (b) comprehension strategies instruction, and (c) cooperative learning. During the intervention, students were provided explicit and direct instruction, including modeling,

guided practice, and feedback. To support students with readability, the researchers deconstructed word problems that incorporated complex math terms and removed irrelevant information. Thus, the linguistically modified word problems fell within four categories as follows: (1) basic terms used in general everyday speech, (2) math content and operational vocabularies, (3) advanced math terms with one content-specific meaning attached, and (4) technical terms that have a unique meaning in mathematics language.

Grounded in a dynamic assessment framework, Orosco and colleagues developed and utilized a probing procedure that incorporated a list of five prompts (i.e., know the question, find the important information, set up the equation, solve the problem, and check for understanding) to determine the level of word problems that required more scaffolding. Participants advanced to learning and practicing the next level of word problems once they achieved 100% problem-solving accuracy at the current level. The results showed that participants improved their accuracy percentage score from the baseline to the maintenance phase, indicating that using the DSM was beneficial in assisting Latino ELs in solving increasingly challenging word problems.

Orosco and Abdulrahim (2018) investigated the effects of comprehension strategy instruction (CSI) provided to 78 Hispanic ELs at risk of mathematics learning difficulties. Researchers randomly assigned students to a treatment ($n = 48$) or a control group ($n = 30$). Trained graduate and undergraduate tutors with an education background implemented the intervention in small group settings. Over the course of the intervention, the instructional routine included: (a) modeling read-aloud and asking students to restate the word problem, (b) teaching students how to identify relevant and irrelevant information, (c) paired learning with tutor's feedback, and (d) independent practice. A result of a hierarchical linear model (HLM) analysis showed a significant difference from pretest to posttest for the treatment group compared to the control group on word problem-solving accuracy with a modest effect size of .37.

Paraphrasing strategy. Three studies integrated a paraphrasing strategy into the interventions to facilitate participants' WPS skills (Kong & Swanson, 2018; Moran et al., 2014; Swanson et al., 2019). Kong and Swanson (2018) measured the effects of a paraphrasing strategy intervention for nine ELs at risk of math disabilities. Researchers randomly grouped students into three peer triads and intentionally steered clear of the same classroom teacher effects. Each lesson followed a four-phase teaching sequence (i.e., warm-up, explicit instruction, guided practice, and independent practice). Specifically, when teaching students how to solve one- or two-step word problems, researchers explicitly demonstrated the use of a paraphrasing strategy that includes the following four steps: (1) identify the question and write out the question in one's own words, (2) identify and restate the important information, (3) cross-out the irrelevant information, and (4) solve the problem and write the answer in a complete sentence. The findings showed that the use of a paraphrasing strategy was effective in promoting WPS accuracy. The average Tau-U score was .53, indicating a small effect size for the intervention.

Moran et al. (2014) conducted a randomized control group, pretest-posttest experimental design study to examine the effect of a paraphrasing strategy on the problem-solving performance of students identified at risk for mathematics disabili-

ties. Of the 72 students, 40 students were designated as ELs. All students were randomly assigned to one of three paraphrasing conditions: the *restate* condition (how to rewrite the question in the word problem in one's own words), the *relevant* condition (rewrite both the question and relevant information), and the *complete* condition (how to rewrite the irrelevant sentence as an additional step). The Principal Component Analysis results showed that problem-solving accuracy improvements were evident among students in the *complete* and *relevant* conditions, with participants demonstrating less achievement in the *control* and *restate* conditions. Though more than half of the students were identified as ELLs at risk for mathematics disabilities, treatment effects were not specified for this group. In other words, this study did not establish treatment effects on ELLs at risk for mathematics disabilities.

Swanson et al. (2019) extended Moran et al. (2014)'s study and further measured if a paraphrasing word problem text strategy improves the WPS accuracy of ELLs and non-ELLs with and without math difficulties. Of the 142 participants, half of the population were Hispanic ELLs, whereas the other half of the students only spoke the English language. Students were randomly assigned to one of the four paraphrasing treatment conditions: *restate* (question and goal), *relevant* (question, goal, and necessary numbers), *complete* (question and all propositions), and control (regular WPS learning). The researchers found that paraphrasing all propositions is effective in promoting WPS accuracy. When examining the performance outcomes of all ELLs, results indicated that they benefited more from the *relevant* condition than the *control* condition. For ELLs with math difficulties, the overall treatment effect was small across three treatment conditions. Specifically, the treatment effect was .22 in the *complete* condition when measuring WPS accuracy in a written format. By contrast, the treatment effect was .23 in the *relevant* condition on the measures of solving word problems orally.

Schema-Based Instruction (SBI). Two studies (Driver & Powell, 2017; Jitendra et al., 2013) utilized schema-based instruction to enhance WPS outcomes. Driver and Powell (2017) studied the efficacy of whether a combined schema instruction (SI) with culturally and linguistically responsive (CLR) practices would promote WPS of ELLs who were at risk of mathematics difficulty. Each participant received a two-phase intervention. The first intervention phase involved general WPS strategy instructions (i.e., read the problem, draw a picture, solve the unknown amount, and provide an explanation). The second intervention phase applied a CLR pedagogy with SI to support WPS skill development. As a result of the CLR-SI intervention, participants demonstrated improved WPS skills, and an effect size of .79 indicated large intervention effectiveness.

Jitendra and colleagues (2013) compared the efficacy of two types of WPS instructions provided to 136 students identified as at risk of mathematics difficulties. Of the sample students, 46.7% were ELLs. Students were randomly assigned to either the standards-based curriculum (SBC) condition or the SBI condition. Students in the SBC treatment condition engaged in instructional activities that aligned with the teaching objectives of the school math curriculum. In comparison, the SBI condition emphasized the skill development of identifying the schema from one- or two-step additive word problems, thus assisting in accurate problem-solving. Results derived from an HLM analysis indicated that SBI students with higher WPS pretest

scores performed better on both the post-test and delayed post-test than the SBC students with higher WPS pretest scores. Relatedly, SBC students with lower WPS pretest scores achieved better outcomes in both post- and retention-test than SBI students with lower pretest scores. ELLs at risk of mathematics difficulty made up nearly half of the sample students per condition, yet information about the treatment effect for this particular group cannot be inferred from the results.

Model Drawing Strategy (MDS). Sharp and Dennis (2017) investigated the intervention effects of a model drawing strategy on the WPS of three Hispanic students with a specific learning disability in mathematics. One of the participants was identified as English for Speakers of Other Languages (ESOL). Over the course of the intervention, a particular instructional emphasis was given to bar diagram drawing to help students represent the known and unknown components of the word problem on the bar diagram they created. In addition, four training lessons focusing on fractions knowledge were implemented before the six MDS intervention lessons. Intervention outcomes were evaluated by students' successful completion of a series of 17 actions in solving each one of five fraction word problems. The results revealed that the MDS intervention package was effective with an average effect size of 1.0, indicating a large intervention effect.

Concrete-Representational-Abstract (CRA) Instruction. Kim et al. (2015) examined the effects of CRA sequenced explicit instruction on fraction word problems. Participants included two Chinese and one Korean low-achieving ELs. In this study, the intervention implementation followed a three-level instructional sequence inherited from CRA instruction. Specifically, at the concrete level, individual participants learned how to form a fraction using manipulatives (e.g., wood stick, cup). Then, at the representational level, participants were instructed to draw pictures to represent the fractions rather than using concrete objects. At the final abstract level, participants were only allowed to use mathematical symbols and numbers to represent the fractions. The finding suggested that the CRA intervention was effective and caused a functional relationship.

Computer-Assisted Instruction (CAI). Xin et al. (2020) integrated CAI into their interventions to enhance students' WPS skills and assessed the intervention effect of a CAI program (*Please Go Bring Me-Conceptual Model-Based Problem Solving, PGBM-COMPS)* on four ELs with learning difficulties in mathematics. The researchers designed their intervention based on a *COMPS* strategy. The *COMPS* tutor first taught fundamental mathematical concepts pertinent to additive reasoning by engaging students in activities such as composing or decomposing numbers using virtual manipulatives. Then, building on this essential knowledge, the CAI focused on promoting student understanding and constructing a generalized mathematical model equation "P + P = W" (Xin et al., 2020) through representing and solving different *combine* and *change* types of word problems. Since all participants made learning gains in this study, the authors concluded that the CAI intervention positively impacts students' ability to solve additive word problems. An overall post-intervention effect size of .96 indicated a large intervention effect.

Multi-Component Intervention Package. Kingsdorf and Krawec (2016) evaluated the effectiveness of a multi-component intervention on WPS of students who belonged to one of the following categories: with identified learning dis-

abilities, at risk of learning disabilities, and/or ESOL. Students received intervention from their classroom teacher during regular math periods at school. The intervention incorporated the following instructional components: (a) explicit instruction with multiple exemplars, (b) visually representing the word problem, and (c) the use of a paraphrasing self-monitoring checklist. The results demonstrated positive intervention effectiveness across the three targeted behaviors of paraphrasing, visualization, and computation of word problems. However, given that only the paraphrasing instructional components were presented across all intervention sessions, drawing a conclusion about which individual intervention component plays a more significant role was difficult. Also, since each student status classification was mutually exclusive, intervention effectiveness for ELs was unclear.

Discussion

The current review of existing literature focused on investigating mathematics WPS interventions within the last decade on ELs with or at risk for math difficulties or disabilities. The following section presents several identified discussion points: language and disability characteristics of the participants, identification criteria of students with or at risk for math difficulties or disabilities, and intervention strategies.

Participant Language and Disability Characteristics

The literature included in this review revealed a notable inconsistency in describing participants' language and disability characteristic across studies. For instance, studies adopted terms such as ELLs, ELs, or ESOL when referring to individuals who use a language other than English at home as their native language. However, an examination of the 14 studies shows an inadequacy in data concerning specific language barriers, and there was no indication regarding the placement of participants in English language programs within their educational settings. Such gaps highlight the necessity, as posited by Sanatullova-Allison and Robinson-Young (2016), for a more careful examination of students' language competencies when determining whether students have or are at risk for math difficulties or disabilities. This examination is especially important in the identification of students who do not possess or are in the process of acquiring English language proficiency while concurrently experiencing challenges in mathematics.

In terms of disability characteristics, two studies (Kingsdorf & Krawec, 2016; Sharp & Dennis, 2016) included a total number of five ELs identified with a specific learning disability, whereas the rest of the ELs ($n = 233$) who experience challenges in mathematics were described using the term such as at risk of math difficulties or learning difficulties in mathematics. The divergence in terminology, while subtle, manifest a discernible lack of consensus within the field and may obstruct the comparability and interpretability of findings across studies.

In addition, although the reviewed studies consist of students from different racial and ethnic backgrounds, details such as native language or the number of years studying in the U.S. are unknown. Recognizing competencies in both English and native languages is important when identifying students with or at risk for math difficulties or disabilities, especially among ELs (Moschkovich, 2013). Also, there was little discussion regarding participants' previous learning experiences and the sub-

sequent effects on their math achievement, such as WPS performance. According to Moschkovich (2013), equitable mathematics instruction must be informed by an understanding of students' prior experiences with mathematics content. Therefore, recognizing and integrating the factors related to language and educational background may substantially enhance our understanding of challenges faced by the ELs, paving the way for informing more effective instructional strategies and targeted interventions.

Criteria for Identifying Students with or at risk for Math Difficulties or Disabilities

The variation in identification criteria for ELs with or at risk for math difficulties or disabilities is evident across the studies included in this review. For instance, in one study, Orosco and colleagues (2013) identified participants as at risk for math failure/disability if they performed at or below the 35th percentile on the subtest 10 - *Applied Problem* from the WJ NU III-ACH Test. In comparison, using the same assessment tool, three other studies conducted by Orosco and colleagues (2013; 2014a; 2014b) utilized a cutoff below the 25th percentile for identifying ELLs at risk for math disabilities. Alternatively, Jitendra et al. (2013) used a cutoff score of below the 40th percentile on a district measure to identify students with math difficulties. Swanson et al (2019) considered children below the 35th percentile on normative calculation measures as at risk for math difficulties. The variation existed in the identification criteria not only underscores the prevailing controversy over the definition of math disabilities, but also reveals an absence of generally agreed-upon criteria for determining students at risk for math difficulties (Jitendra et al., 2013; Swanson et al., 2019). Such discrepancies in defining and identifying disability status can exert a profound impact on stakeholders' selection of appropriate intervention strategies/practices, potentially resulting in undesired intervention outcomes. Furthermore, the terminology used, whether "disability" or "difficulty", conveys specific information indicative of the level of disability severity, thereby informing intervention planning. As such, a clear distinction between these two terms warrants particular attention when research studies attempt to define students' disability status.

Intervention Characteristics

The outcomes of the 14 studies suggest that strategy instruction effectively supported the development of WPS skills for ELs with or at risk for math difficulties or disabilities. Among these, eight studies were centered on comprehension strategy instruction, with five studies focused on an enhanced understanding of the word problem text (e.g., Orosco et al., 2013), and three studies have shown the benefits of paraphrasing the word problem propositions and the question in promoting WPS accuracy (e.g., Kong & Swanson, 2018). Rather than establishing the intervention focuses on language processing and comprehension, two studies emphasized that students could solve word problems by identifying the problem structures (Jitendra et al., 2013; Driver & Powell, 2017). Concerning that achieving competency with both fractions and fraction word problems is especially challenging for students with or at risk for math difficulties and disabilities (Namkung & Fuchs, 2019), Sharp and Dennis (2017) utilized a model drawing strategy (i.e., drawing fraction bars) to facilitate fraction knowledge and fraction WPS. Likewise, Kim et al.'s (2015) interven-

tion incorporated a CRA instructional sequence in supporting Asian students with significant math difficulties in developing fraction WPS skills. Additionally, Xin and colleagues (2020) used a computer-mediated intervention, and students learned how to solve word problems from the "intelligent tutor". As the only study incorporating multiple intervention components, Kingsdorf and Krawec's (2016) study showed positive results across the three targeted behaviors. Finally, a commonality across all 14 studies was the implementation of explicit instructional procedures during the intervention, offering ample opportunities for direct modeling, guided and independent practice, thereby fostering optimal WPS learning outcomes.

Limitations and Implications for Future Research

This study was subject to several limitations. First, this literature review only included peer-reviewed journal articles, publications such as dissertations, policy briefs, and technical reports were excluded. Therefore, the positive WPS intervention effectiveness might be inflated due to literature search bias. Second, only 14 studies met the inclusion criteria for this literature review, with less than one-third of studies ($n = 4$) published within the last five years. This number is extremely small compared to research pertaining to enhancing the WPS skills in non-ELs with or at risk for math difficulties or disabilities. Thus, the results urge more research studies to be conducted to provide more empirical evidence on teaching word problems to elementary ELs with or at risk for math difficulties or disabilities. Third, of the 14 reviewed studies, participants were mainly comprising students in the third grade. This is likely because students started to interact intensively with word problems in upper elementary grades and implementing intervention for ELs with significant difficulties in WPS is critical. However, little attention has been paid to second- and fourth-grade students, and no study has included fifth-grade students. Altogether, these data underscore the necessity of broader research encompassing students from different elementary grade levels, mainly because ELs' needs in learning mathematics and English language proficiency can vary significantly across grades. Lastly, most studies provided interventions for solving one-step additive and/or multiplicative word problems. Therefore, in response to the educational requirement for elementary students, immediate future research is warranted to address the needs to solve multi-step word problems involving four operations.

Implications for Practice

The findings of this literature review offer several practical implications. First, more than half of the intervention studies emphasized comprehension of the word problem text effectively promoted WPS outcomes in ELs with or at risk for math difficulties or disabilities. This elucidates how language skills intertwine with conceptual understanding in mathematics and highlights the importance of teaching necessary English language skills to enhance word problem-solving comprehension (Espinas & Fuchs, 2022). Second, as SBI has demonstrated large intervention effects in ELs and non-ELs with WPS difficulties (Griffin et al., 2018; Powell & Fuchs, 2018), teachers are encouraged to use schematic diagrams to support students in developing WPS skills. For instance, teachers may consider including instructional components such as identifying problem schema (e.g., Part + Part = Whole; Fuchs et al., 2015),

recognizing quantities (e.g., groups, objects), and representing the mathematical relationships of any given one-step word problem. Third, incorporating explicit and systematic instruction has shown strong evidence for teaching mathematics skills (Gersten et al., 2009). Thus, teachers can help students struggling to solve mathematical word problems by following explicit instructional procedures. In that way, students can potentially improve their WPS skills through the opportunities of systematic teacher modeling, and profound guided and independent practice.

Conclusion

Word problem-solving is one of the critical mathematical skills emphasized in the school curriculum. Many students struggle with solving word problems at the elementary school level. This literature review identified and synthesized existing WPS intervention strategies and practices, reflecting the need for future research geared towards developing WPS skills for ELs with or at risk for math difficulties or disabilities, and provided practical recommendations for teachers who collaborate with ELs experiencing WPS difficulties. This study also underscores the importance of a comprehensive and consistent approach to assessing and identifying ELs with or at risk for math difficulties or disabilities, enabling more effective and tailored interventions that address the unique learning needs in ELs.

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