Effects of a Technology-Assisted Reading Comprehension Intervention for English Learners with Learning Disabilities

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─────── **Abstract** ───────

This study integrated technology tools into a reading comprehension intervention that used explicit instruction to teach strategies (i.e., asking questions, making connections, and coding the text to monitor for meaning) to mixed-ability small groups, which included four English learners with learning disabilities in a fourth-grade general education classroom. We used a multiple baseline design across participants to evaluate the effects of instruction on strategy application as measured through comprehension rubrics (Keene, 2006) and on comprehension-question answering as measured through researcher-developed literal and inferential comprehension questions. Results showed that participants applied comprehension strategies and improved their percentage accuracy with answering comprehension questions after being introduced to explicit strategy instruction, a mnemonic to facilitate strategy application, web-based tools, and peer collaboration to co-construct meaning from text. Participants perceived the instructional technology tools (i.e., mind-mapping applications, web-linked text, weblogs, and an interactive whiteboard recording application) and reading comprehension strategy instruction as helpful. Implications for future research and practice are discussed.

KEYWORDS: English learners, learning disabilities, reading comprehension, instructional technology

In classrooms today, diversity is present not only in terms of cultural membership, racial background, or ability level but also in terms of students' linguistic backgrounds and language-learning histories. More than 4.5 million children in U.S. public schools speak a home language other than English (U.S. Department of Education, National Center for Education Statistics, 2013). Of students who are in the process of acquiring English as an additional language, a higher than expected percentage are identified as eligible for special education services under the specific learning disability classification (Sullivan, 2011). A learning disability (LD) is generally defined as:

> a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to think, listen, speak, read, write, spell or perform mathematical calculations that cannot be explained by factors such as socioeconomic status, cultural differences, emotional disturbance, sensory or cognitive impairments, or environmental factors. (Individuals with Disabilities Education Improvement Act [IDEIA], 2004)

When evaluating specific students due to academic concerns that have persisted despite interventions provided through a culturally responsive multitiered system of supports (MTSS), multidisciplinary teams must carefully consider factors related to a language difference that can influence academic achievement. For example, in the area of reading, behaviors associated with second language acquisition (e.g., slow rate of oral reading or difficulty with retelling a story) overlap with behaviors demonstrated by students with LD (Klingner, Artiles, & Mendez-Barletta, 2006). Distinctions can be made about causal factors by applying a bilingual/second language acquisition-informed and a special education/disability-informed lens. In addition, multidisciplinary teams can attend to external factors (e.g., biased assessments or inappropriate interventions), guard against deficit-based thinking, and create culturally responsive learning environments to support the process of discerning disability from difference.

When an appropriately identified LD intersects with English learner (EL) status, students face challenges with acquiring information from English-only text (Klingner et al., 2006). The literacy-related challenges that ELs with LD face are frequently associated with long-term outcomes that include increased drop-out rates, decreased employment opportunities, and grade retentions (Abedi, 2002; Snyder & Dillow, 2012). To support biliteracy development in ELs with LD, there is a need for instruction that can effectively promote language use while addressing disability-related literacy needs. Moreover, such instruction must respond to and equip students for meaning-making practices in 21st century literacy contexts.

Reading Comprehension Instruction for ELs with LD

The topic of effective literacy instruction for ELs with LD is in an emergent state in the literature (Richards-Tutor, Baker, Gersten, Baker, & Smith, 2016). The extant body of research indicates that improvements in reading comprehension for ELs with LD have been achieved through explicit strategy instruction that incorporates opportunities for peers to collaborate to negotiate meaning from texts while making predictions, asking questions, or using schema (e.g., Boardman et al., 2016; Klingner & Vaughn, 1996; Sáenz, Fuchs, & Fuchs, 2005). Deliberately including opportunities for ELs with LD to use language to interact with fluent English speakers with and without identified disabilities is facilitated through several instructional methods. One method, a modified version of reciprocal peer tutoring, was found to be effective for ELs (with Spanish as a native language and early-intermediate English proficiency levels) with LD in seventh and eighth grade (Klingner & Vaughn 1996). The collaborative strategic reading (CSR) model emerged from this modified version of reciprocal peer tutoring. CSR emphasizes collaborative conversations around text to monitor comprehension, figure out word meanings, determine importance, and summarize. Boardman and colleagues (2016) reported significant gains ($g = .52$) on measures of reading comprehension when fourth- and fifth-grade students with LD, including ELs (native Spanish speakers), participated in 14 weeks of CSR; however, the results were not disaggregated for ELs with LD. Another method, peer-assisted

learning strategies (PALS), involves reading, retelling, summarizing, and predicting. In a PALS study that included ELs (native Spanish speakers with varying levels of English proficiency) with LD in grades 3 to 6, Sáenz and colleagues (2005) reported significant gains on a comprehensive battery of reading comprehension assessments after 15 weeks of instruction. Given the strong results obtained for ELs with LD on researcher-developed and standardized measures of reading comprehension achievement in each study, interventions aimed at building reading comprehension skills should continue to facilitate opportunities for ELs with LD to work collaboratively with peers, thus making language accessible while also eliciting meaningful language production. However, there is a need to look at the specific developmental process of reading and constructing meaning used by ELs with LD through multiple means of assessment (e.g., formative in addition to summative assessment).

Technology Innovations in Supporting Reading Comprehension

Technology holds the potential to play an important role in promoting literacy development for all students (Cummins, Brown, & Sayers, 2007). In two reading comprehension intervention studies that included ELs without disabilities or monolingual students with LD, researchers explored effects of embedding web-based tools into the teaching process by using an instructional method found to be effective for ELs with LD. In the first study, Kim and colleagues (2006) implemented a CSR with a computer-assisted instruction (CAI) component for monolingual, middle-school students with LD. Intervention sessions took place over a 12-week period, with 50-minute sessions occurring twice per week. Researchers reported statistically significant gains on posttest measures of reading ability. Additionally, qualitative reports indicated that participants enjoyed the intervention and that they perceived growth in their reading ability as a result of participation in the CAI treatment. Based on the reported effectiveness of CSR for ELs with LD, there remains a need to explore the effects of infusing technology tools into reading comprehension interventions.

In the second study, Proctor, Dalton, and Grisham (2007) delivered a universally designed reading comprehension intervention to 30 students (16 of whom were ELs without disabilities). During the 4-week intervention, participants read both narrative and informational electronic-texts (e-texts) with embedded hyperlinks to enhance vocabulary, activated text-to-speech functionality, and embedded pop-ups to prompt use of comprehension strategies (e.g., predicting, questioning, using schema, monitoring for meaning). Strategies were taught explicitly, as in previous studies that included ELs with LD; however, the technology tools replaced the role of the peer tutor. Slight gains were made from pre- to posttests on a reading comprehension achievement measure, with some participants' growth significantly exceeding that of others. Researchers observed that participants made use of embedded technology supports to meaningfully interact with text. This led to the conclusion that technology supported participants in recognizing when a breakdown in reading for meaning was occurring.

In considering the capacity that technology tools have to support literacy development for ELs with LD, it is necessary to explore use of tools to support language production and the learning process. Castek and Beach (2014) describe how specific tools can be integrated into literacy instruction to support collaboration and shared productivity. For example, concept-mapping applications allow students to develop and expand ideas around a common topic. In addition, electronic sticky notes can be used to signal questions or connections between the text and students' prior knowledge. Finally, screencasting applications mediate communication by allowing students to import images to a virtual

whiteboard onto which they can add notes and record audio to share thinking. There remains a need to explore the potential of merging tools that support collaboration and shared productivity into an explicit instruction framework to support development of reading comprehension strategies for ELs with LD.

The Current Study

The process of biliteracy development is influenced by myriad variables (e.g., personality factors, motivation levels, language proficiency levels, instructional factors, socioeconomic status, home literacy practices, and length of time in the United States) that uniquely intersect with the presence of a disability and contribute to individualized learning needs (August & Siegel, 2006). To respond to individualized needs, we designed an intervention that included two phases. In phase one, we mirrored standard-practice instruction in the research setting (e.g., guided reading, vocabulary instruction). In phase two, we introduced multicomponent instruction, which was intended to support the unique language and literacy needs of ELs with LD using findings from the extant research base. Our purpose in this study was to systematically evaluate the effects of providing explicit instruction to teach reading comprehension strategies (e.g., asking questions, making connections, and coding the text to monitor for meaning) while incorporating instructional technology and productivity tools (i.e., mind-mapping applications, web-linked text, weblogs, and a screencasting application) and structured opportunities for peer collaboration.

We selected a research design in which we could rely on direct observation of daily performance with tasks related to reading comprehension (e.g., applying comprehension-monitoring strategies) to evaluate progress so that adjustments could be made to instruction to respond to individual needs and keep students on the path of learning (Sztajn, Confrey, Wilson, Edgington, 2012). With a formative assessment process intended to yield ecologically valid data, we aimed to iteratively refine instruction and contribute to an understanding of "where, when, why, and for whom" the intervention works (Gutiérrez & Penuel, 2014). Three research questions guided the study:

1. When supported by instructional technology tools and frequent opportunities for peer collaboration, what are the effects of explicit reading comprehension strategy instruction on (a) participants' application of comprehension strategies as measured through comprehension thinking strategy rubrics (Keene, 2006) and (b) participants' accuracy with verbally responding to researcher-developed text-related literal and inferential comprehension questions?

2. How does participation in the intervention affect participants' perceptions of themselves as readers?

3. What are participants' satisfaction levels with the materials and procedures of the study?

Methods

Participants

To select potential participants, we first reviewed records to locate students who took the Assessing Comprehension and Communication in English State-to-State (ACCESS) for English Language Learners test and earned composite English-language proficiency scores between 3.0 and 4.9. This range signified an intermediate to advanced English proficiency level. At this level, ELs expand on others' ideas and contribute ideas to cocreate group responses (WIDA, 2010). We selected grade 4 because the greatest number of ELs with intermediate to advanced proficiency were enrolled in this grade level.

Of the ELs in grade 4, we selected those who also received special education services. Each participant had an individualized education program (IEP) under the SLD eligibility, and IEP goals related to reading comprehension, reading fluency, and written expression. For each participant, special education eligibility was determined up to 2 years prior to the beginning of the study through a Response to Intervention (RTI) model that incorporated a multidisciplinary team's analysis of academic performance on multiple measures (e.g., standardized tests, curriculum-based assessments, observations, and interviews), with testing in both English and the native language (i.e., Spanish or Arabic). Results of the comprehensive evaluation reflected significant difficulties with reading and writing across languages. Ultimately, we obtained consent to participate for four ELs with LD.

Ahmad. Ahmad was a White male student, aged 9 years, 10 months. He became eligible to receive special education services 1 year prior to the start of the study. These services included 450 min per week of direct instruction in reading and writing from a special education teacher. He began receiving EL services in the early childhood program at age 4. For the majority of his school career, he received English as a Second Language (ESL) pull-out services; however, in grade 3 the program changed to a part-time transitional bilingual education (TBE) program delivered through push-in services (i.e., Arabic/ English instruction). His instructional reading level in English, measured by the Fountas and Pinnell Benchmark Assessment System (BAS), was level L, or 1.5 years below grade level. Ahmad spoke Arabic and English at home. Running records conducted in Arabic by a native Arabic-speaking bilingual teacher revealed that he read in Arabic at a level B, in the Kindergarten range. His composite English proficiency composite score was 4.9 on the ACCESS test, a late-intermediate to advanced level of English proficiency.

Jorge. Jorge was a Latino student, aged 10 years, 1 month. He became eligible to receive special education services 1 year prior to the start of the study. Special education services entailed 300 min per week of direct instruction in reading and writing from a special education teacher. His native language was Spanish. He self-reported that he could read and write in English better than he could in Spanish. He began receiving ESL pull-out services in Kindergarten. In the beginning of second-grade, the program model changed and offered part-time TBE push-in services (i.e., Spanish/English instruction). On the Spanish BAS (i.e., sistema de evaluacción de la lectura), Jorge read at level E (mid- to late-first grade level). His instructional reading level in English on the BAS was level L, or 1.5 years below grade level. Jorge's overall English proficiency was 4.9 on the ACCESS.

Sofia. Sofia was a Latina student, aged 9 years, 6 months. She became eligible to receive special education services 2 years prior to the start of the study. These services targeted areas of reading and writing and offered 450 min per week of direct instruction from a special education teacher. Her native language was Spanish. She reported that she could speak and understand Spanish but could not read or write in Spanish. She began receiving ESL services in the early childhood program at age 3. These services lasted until second grade, when she began receiving part-time TBE services (i.e., instruction in Spanish/English). On the BAS in Spanish she read at a level B (Kindergarten level). Her instructional reading level in English on the BAS was level K, or 2 years below grade level. Her composite English proficiency on the ACCESS was 4.3, at the intermediate stage.

Khaled. Khaled was a White male student, aged 9 years, 4 months. He became eligible to receive special education services 18 months prior to the start of the study. These services targeted areas of reading and writing and offered 450 min per week of direct

instruction from a special education teacher. Khaled spoke some Arabic but reported using mostly English at home, as his parents and siblings were bilingual. He enrolled in the early childhood program at age 3 and began receiving ESL services. At the start of third grade, ESL support was replaced with EL services through the part-time TBE program (i.e., instruction in Arabic/English). His English language proficiency was at the intermediate stage (3.6). Running records conducted in Arabic by a native Arabic-speaking bilingual teacher showed that he read at level A, the early Kindergarten level. His instructional reading level in English on the BAS was level E, or 3 years below grade level.

Setting

This study, approved by the Institutional Review Board at the authors' university, took place in a Midwestern elementary school, with an enrollment of 579 students. The majority (75.1%) of the school population was White. English learners comprised 11.2% of the school population (with Arabic or Spanish as a home language). Students with disabilities comprised 15.2% of the school population, and 34% received free or reduced lunch. Fourth-grade ELs received language-related services in the general education classroom, with native-English speaking peers, through a part-time TBE program. Native language instruction was provided through a push-in service delivery model in which the bilingual teachers cotaught during content area classes (i.e., used parallel teaching to deliver instruction to a small group during science or social studies) on a daily basis. In addition, a push-in service delivery model was used to deliver special education services to students with LD in the general education classroom. To meet needs documented on participants' IEPs, a bilingual/ESL special education teacher cotaught with the general education teacher during literacy and with bilingual teachers during science.

Research activities took place at the back of a fourth-grade general education classroom during a 120-min block of instruction. Intervention sessions, conducted by the first author, involved small groups of students (i.e., one participant and up to five nonparticipants per group), lasted 30 min, and met 5 days per week. Small groups included mixed-ability levels (i.e., different instructional reading levels), various language backgrounds (e.g., a group included two native English speakers, one participant, and one student who exited from EL services), and common strengths (e.g., perseverance, creative talent, problem-solving skills).

A modified version of station teaching was used to deliver instruction throughout the entire literacy block. We divided the literacy block into four 30-min periods, and every student rotated through four stations each day with members from their small group. The first author, a White special education teacher with bilingual (Spanish/English) and ESL special education teaching credentials provided small-group instruction at one station, for the full 120 min, focusing on reading comprehension. During the periods in which Khaled's and Ahmad's groups separately rotated through the reading comprehension station, a bilingual paraprofessional (Arabic/English) supported instruction. When not in the reading comprehension station, participants rotated with their small group to any of three other stations, which involved independent reading or writing and conferencing with the general education teacher or completing student-led activities related to reading fluency, grammar, or vocabulary.

Materials

E-texts and web-based tools. We incorporated instructional technology and productivity tools into the intervention. This included mind-mapping applications (i.e., iThoughts HD); electronic sticky notes; e-texts with words hyperlinked to online dictionaries; a weblog (i.e., kidblog); and a screencasting application (i.e., Educreations).

Instructional level texts. Prior to the start of the study, we selected an equal number of fiction and nonfiction texts and e-texts written at students' instructional reading levels on the BAS, a criterion-referenced test used as a universal screener in the school district.

Mentor texts. We read aloud mentor texts while modeling reading comprehension strategies. We used trade books as mentor texts to demonstrate authentic language, as opposed to contrived but decodable text. At least one mentor text in the narrative genre reflected a main character whose cultural and linguistic background resembled one of the participants,' while telling a story to which others could relate due to universal themes (e.g., friendship, honesty). We provided direct experiences (e.g., examining a frozen glass for condensation), images, realia, and discussion to build schema prior to reading aloud mentor texts. The following titles were selected as mentor texts: *One Green Apple* (Bunting, 2006), *A Day's Work* (Bunting, 1994), and *One Well: The Story of Water on Earth* (Strauss, 2007).

Dependent Measures

Reading comprehension strategy rubric. We used Keene's (2006) rubric for monitoring comprehension. Behaviors signifying the application of the comprehension thinking strategies were described at five levels. Scores ranged from 1 to 5, with 5 representing the highest level of sophistication. Scores were assigned after giving a verbal prompt (e.g., *Tell me what you were thinking as you read about*…) and listening to responses.

Comprehension questions. We developed a fixed number of literal and inferential questions to evaluate comprehension of instructional level texts. A team of reading specialists crosschecked all questions to ensure content validity prior to the use of the questions in this study. For texts written below level K, we prepared five literal and five inferential questions. For texts written at and above level K, we prepared six literal and six inferential questions. After orally posing the questions, the first author listened to participants' verbal responses and evaluated the accuracy and completeness of the response. For each participant in each session, the total number of accurate, complete responses was divided into the total number of questions posed and was multiplied by 100.

Perceptions of reading and of the intervention. Each participant shared perceptions during an individual interview administered prior to and again after exiting multicomponent instruction. Eight open-ended interview questions were adapted from the *Motivation to Read Profile: Conversational Profile* by Gambrell, Palmer, Codling, and Mazzoni (1996). Three questions focused on reading behaviors (e.g., *Did you read anything at home yesterday?*). Three focused on perceptions of self as a reader (e.g., *What do you need to learn to be a better reader?*). Two focused on reading motivation (e.g., *Do you know any books you would like to read?*). To gather perceptions about the social acceptability of the materials and procedures used during the intervention, we administered a four-item Likert-style survey to gauge satisfactions levels on a 6-point rating scale.

Research Design

Given the exploratory nature of the investigation and the small number of participants, we used a multiple baseline design across participants (Gast & Ledford, 2010) to analyze the effects of the intervention on participants' application of targeted reading comprehension strategies. With this design, each participant serves as his or her own control. We repeatedly measured performance with strategy application and comprehension-question answering and graphed data to visually inspect level, trend, and immediacy of effect across participants. Frequent formative assessment allowed for adjustments to the intervention. The multiple baseline design controls replication of effects across phases (i.e., baseline sessions resembling standard-practice instruction and a multicomponent phase of the intervention) to corroborate a functional relation, or systematic change in performance. By staggering the introduction of the multicomponent phase across participants, we could conclude that any change in performance was the result of multicomponent instruction rather than chance.

Phase changes. The scores on reading comprehension strategy rubrics held primary influence over decisions about when to change phases. Upon achieving a stable or decreasing rubric score after five sessions in the baseline phase, we introduced the multicomponent phase of the intervention to Ahmad while Jorge, Sofia, and Khaled continued with baseline sessions. When Ahmad attained a consistent rubric score of 3 or greater for three sessions during the multicomponent phase, Jorge moved from baseline sessions into the multicomponent phase. This pattern continued until all participants moved from the standard-practice phase of the intervention (i.e., baseline sessions) into the multicomponent phase of the intervention. After completing 15 sessions in the multicomponent phase and earning scores of 4 or 5, participants moved into maintenance assessment for three sessions (one session per week).

General Procedures

The study spanned 12 weeks and involved 29 to 39 sessions per participant. The difference in number of sessions across participants is attributed to the time it took to achieve stability during the baseline phase and/or the time it took for the preceding participant to earn three consecutive rubric scores of 3 or greater during the multicomponent phase of the intervention. Standard practice instruction lasted 5 to 14 sessions, varying across participants. The adjacent multicomponent phase lasted up to 5 weeks. Maintenance assessment occurred once per week for 3 weeks.

During each session, across phases of the study, English was the primary language of instruction. We took steps to make written and spoken language accessible by using images, demonstrations, and real-life objects. In addition, we used participants' native languages to clarify the strategies (e.g., questioning, using schema, coding text) or to restate task directions when participants expressed uncertainty after initial statements were made in English. The first author provided native language clarification in Spanish for Sofia and Jorge. A bilingual (Arabic/English) paraprofessional supported sessions and provided clarification in Arabic for Ahmad and Khaled.

Pre/post data collection. A district-employed reading specialist administered the BAS in English 3 to 9 days prior to the first baseline session. The same district-employed reading specialist administered the BAS in English immediately upon exiting the multicomponent phase of the intervention. In addition, the first author conducted individual interviews with participants before and after the intervention. Participants gave verbal and

written responses to eight open-ended questions about reading motivation. We read written responses, analyzed notes, and identified themes to gain insight into participants' attitude and self-efficacy as readers.

Baseline sessions. The goal of the baseline sessions was to provide a context that resembled standard-practice instruction while collecting data to identify participants' performance with application of comprehension-thinking strategies and accuracy with responding to comprehension questions. The first author delivered instruction using one text per student in each group. Within groups, she selected texts on a central topic, written at each student's instructional reading level. Instruction focused on reading comprehension (e.g., idea mapping, making/confirming predictions) and vocabulary development using the Frayer model (Frayer, Fredrick, & Klausmeir, 1969). Instructional procedures are sequenced in Table 1.

Table 1
Sequence of Actions during Baseline Sessions and Maintenance Assessment

Sequence	Actions
Before Reading	1. Students set a goal related to reading. For example, "I will read 100 words with fewer than 2 miscues," or "I will read with expression."
	2. Ask questions to activate prior knowledge and use paper to have the group create one idea web. For example, before reading about a main character who had a secret, ask "Have you ever known about something but tried to keep it a secret so you could surprise someone else?"
	3. Each student in the group scans their text and shares one prediction.
	4. Use the Frayer model to target one vocabulary word related to text topic.
During Reading	5. Students read from instructional-level text to confirm or disconfirm predictions. Students use sticky notes to code text or jot notes.
	6. Pose discussion questions to the small group related to general text topics; listen to responses and restate or pose follow-up questions.
After Reading	7. For each participant, pose scripted comprehension questions. Paraphrase responses. Record (+) or (-) to code accuracy of responses
	8. Provide prompt to elicit from each participant a description of strategies used while reading. Assign a score using comprehension strategy rubric.
	9. Ask students to reflect on the goals they set at the start of the session.
	10. Have students verbally pose questions, make comments, and offer insights by writing in a reader's notebook

Multicomponent instruction sessions. During this phase, procedures were similar to baseline sessions (e.g., goal setting, idea mapping, and use of the Frayer model); however, four new components were infused into instruction. These components, which were simultaneously introduced, included: (a) explicit strategy instruction, (b) a mnemonic, (c) web-based tools, and (d) peer collaboration. See Table 2 for the sequence of instructional procedures.

Table 2
Sequence of Actions during the Multicomponent Phase of the Intervention

Sequence	Actions
Before Reading	1. Students set a goal related to reading. For example: I will state how the text reminds me of something I have read about before.
	2. Ask questions to activate prior knowledge; have partners use mind-mapping applications to cocreate idea webs to connect text topic to schema.
	3. Partners visually scan the text and interactively share predictions.
	4. Partners use the Frayer model for one vocabulary word per text.
	5. Introduce (or review) comprehension strategies. Script for introducing: Today I will show you a strategy called text coding. Text coding is a strategy that readers can use to monitor for meaning. When I code the text, I leave tracks of my thinking. This means that you will see what I think as I read. I will read part of the book _____ to you today. I will leave tracks so you can follow my thinking on sticky notes. The word TRACK reminds me of the steps I need to follow. T reminds me to think while I read. R reminds me to react to the text. This means that when I notice my thinking, I do something. For example, if I am confused, I will reread or read ahead to see if I can figure out what the author means. A reminds me to ask questions. Some questions can be answered in the text; some questions might not be answered at all. C reminds me to connect to what I am reading. Good readers make connections between the books they read and their own lives. K reminds me to keep track of my thinking. To track thinking, I will use symbols. Some symbols are "?" to show that I am asking a question, "*" to show that I made a connection because something reminds me of what I know, and "!" to show that something I read was interesting. Now, I am going to read and think.
During Reading	6. Modeling only: Read aloud from mentor text. Use TRACK to code text. Use sentence starters: Questioning: "I wonder why the author chose to …" Using schema: "This reminds me of …" Monitoring: "I am confused about…".
	7. One partner reads to a designated stopping point and uses sentence starters to think aloud. The other partner offers prompts (e.g., What does this remind you of?) to interactively construct meaning from text. Then, partners switch roles
	8. Students continue reading and using e-sticky notes and TRACK to code the e-texts as they read, choosing when or whether to access embedded hyperlinks.
After Reading	9. Students use Educreations to take a still shot of a passage and record themselves explaining strategy use.
	10. Pose scripted comprehension questions to participants. Paraphrase responses. Record (+) for on-target responses and (-) for off-target responses.
	11. Ask each participant to talk about the text as well and explain how he/she used comprehension strategies; listen to responses. Assign a rubric score.
	12. Students reflect on their goals set at the beginning of the session.
	13. Students pose questions, make comments, or offer insights on weblog.

Explicit strategy instruction. Initially, sessions focused on modeling use of strategies (i.e., asking questions, making connections, and using symbols to code the text to monitor for meaning). This was followed by guided practice with immediate feedback. The remaining sessions allowed for independent practice with strategy use.

Mnemonic to support strategy use. All students gave input to develop a mnemonic to facilitate application of reading comprehension strategies. The mnemonic, TRACK, represented the following actions: Think about what I am reading, React to the text, Ask questions, Connect, and Keep track of my thinking. The mnemonic was used to model comprehension strategy use. Then, students practiced using the mnemonic and received feedback on strategy use. During independent practice, they had to the option to independently apply the mnemonic while reading.

E-texts and web-based tools. Before reading, students used mind-mapping applications to develop collaboratively a web of ideas that connected prior knowledge to the text topics. While reading, students used electronic sticky notes to annotate instructional-level e-texts. While reading e-texts, students used embedded, online dictionaries to determine meanings of any unknown words they encountered. After reading, students used a weblog to post insights, questions, or comments related to instructional level or mentor texts. The general education teacher, other students, and students' families accessed the weblog and posted replies. In addition, we introduced a screencasting application, in which students captured still shots of a self-selected 300- to 500-word passage and then to audio-record explanations of how they applied comprehension strategies while reading the passage.

Peer collaboration. We structured opportunities for members of small groups to collaborate before, during, and after reading. Before reading, group members self-evaluated prior knowledge and verbally exchanged ideas with a partner while using mind-mapping applications to cocreate idea webs related to text topics. In addition, partners within the small group shared text-related predictions with each other before reading. At designated stopping points while reading, group members worked with a partner to offer prompts (e.g., Does what you are reading remind you of anything you know?) to guide strategy application. After reading, participants shared their thinking and interacted with each other using a weblog.

Maintenance sessions. Instruction during maintenance sessions took place in the same manner as the baseline standard-practice sessions. The first author collected maintenance data once per week for three weeks after the completion of the study.

Reliability

Two district-employed interventionists who held master's degrees as reading specialists collected reliability data by observing 25% of the lessons delivered to each participant. One of the interventionists held ESL and special education teaching credentials. The first author trained interventionists to collect reliability data using students not included in the study.

Procedural reliability. Interventionists collected reliability data through direct observational methods using a checklist, formatted with steps listed in Tables 1 and 2, to rate dichotomously whether specific actions took place during each lesson across phases of the study. For both raters, the total number of observed actions was divided by the number of possible actions and then was multiplied by 100 (Billingsley, White, & Munson, 1980) to determine the mean procedural reliability: 95.5% (range 93–97%).

Interobserver agreement. The same two interventionists collected interobserver agreement (IOA) data on application of comprehension strategies and on accuracy with answering comprehension questions during 25% of the sessions delivered to each participant also using direct observational methods. To determine IOA, we divided the total number of agreements by the number of agreements and disagreements and multiplied by 100. On comprehension rubrics, the mean IOA was 94% for Ahmad, Sofia, and Khaled and 96% for Jorge. For comprehension-question answering, the mean IOA ranged from 92 to 100%.

Results

For all participants, scores on the comprehension-thinking strategy rubric increased when the multicomponent phase of the intervention was added (see Figure 1). An increase in rubric scores signified that participants used and applied comprehension-thinking strategies to monitor for meaning in observable ways (e.g., by sharing thinking that related to pictures, by explaining how they solved word-level problems, by adjusting their oral reading rate, or by explaining how their own thinking supported or inhibited comprehension). All results presented below reflect performance during formative assessments administered after independent reading of instructional-level text.
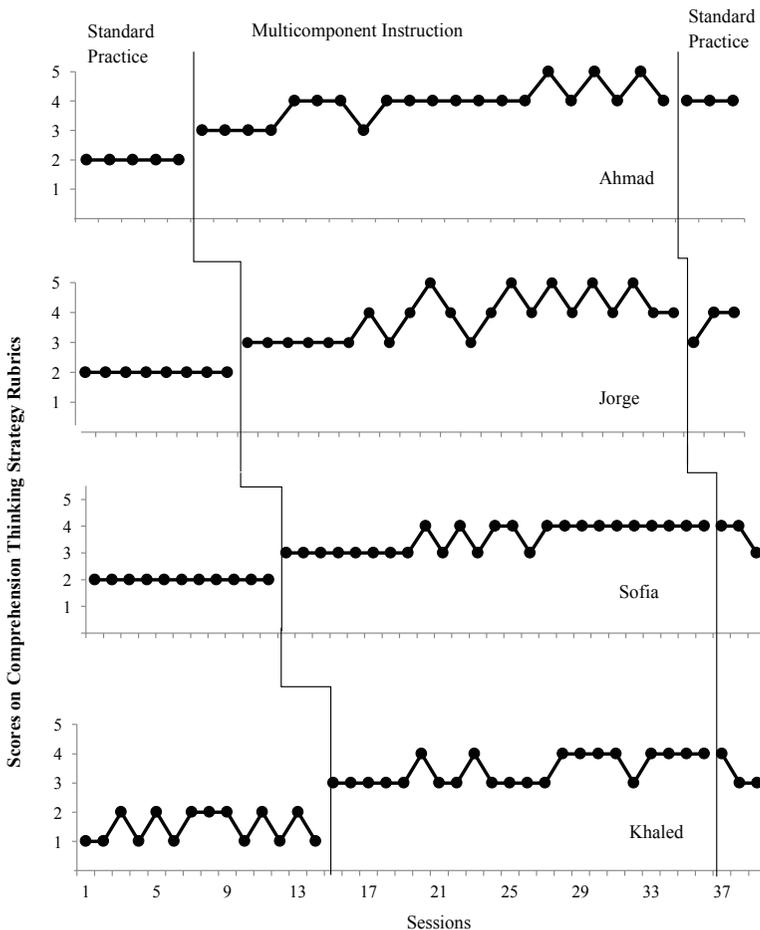

Figure 1. Scores on comprehension thinking rubrics across sessions.

Strategy Use in Baseline Sessions

During the standard-practice phase of the intervention, participants did not yet verbalize or name the strategies they were using to monitor for meaning. Language to name comprehension-monitoring strategies had not been directly practiced during instruction, and the behavior of coding text to track thinking was not formally introduced during this initial phase of the intervention. Similarly, strategies related to questioning or using schema were not explicitly taught or practiced during this phase of the intervention.

Connections to messages presented through titles or images. Most of the questions that Ahmad, Jorge, Sofia, and Khaled posed during formative assessments in the standard-practice phase of the intervention were anchored to ideas communicated through either the title of the text or through the images used to support the text. Likewise, participants stated connections that related prior experiences to the general text topic or to the images depicted. For example, Jorge responded to the prompt, "Tell me what you were thinking as you read about dragonflies" by sharing an experience he recalled that involved an interaction at a nearby park.

> I have seen this at the…[name of nature park near the school]. They fly low. And so much noise! I saw one come at me. So I run AHHH (waving hands). All of them just *zumbando por encima de mi cabeza* (buzzing around my head). I don't like them.

When a follow-up prompt was given, "What did you do to understand what the author wrote about dragonflies?" Jorge replied by turning the page, pointing to an image of a dragonfly, and saying, "…I can see that some of the colors are really… They are weird because…such big eyes. I should see if other ones have those eyes, maybe it's bees."

General text-to-text connections. Beyond trying to negotiate meaning from the images or titles of texts, Ahmad, Jorge, and Sofia also connected what they were reading to interactions with other texts that they previously read or encountered. In stating these connections, participants shared opinions and commented about similarities and differences across texts. For example, Ahmad responded to the prompt, "Tell me what you were thinking while reading about crocodiles and alligators" by connecting to a book series with which he was familiar.

> Well, I was jus' thinkin' about tellin' the author you're wastin' my time because it's BOR-ing! It's not like the "versus" ones [referring to the *Who Would Win?* series]. Those are good. You see who versus who. Who wins. Here (points to book) he just keep telling me some facts (points to a bulleted list that appears one the second page of the text). No. Ok. I'm done with this. I'm 'ma find the Komodo [referring to the book in the *Who Would Win?* series; Pallotta, 2011].

Strategy Use during Multicomponent Instruction

When multicomponent instruction was introduced, all four participants practiced demonstrating specific comprehension-monitoring behaviors that were explicitly taught and that were modeled by partners within the small group. For example, when participants encountered an unknown word, they reread or read ahead to gain context from which to infer meaning. Observable changes in use of comprehension-monitoring behaviors contributed to an increase in rubric scores in this phase of the intervention.

Connections to written messages. As in the initial baseline sessions, all four participants continued to make connections; however, in the multicomponent phase of the

intervention, they began to relate ideas presented through words in the text to their own personal experiences. For example, after reading about a female character who excelled at playing soccer, Sofia responded to the prompt, "Tell me about your thinking while reading about Jessica" by saying,

> I put some connections. (She gestured toward e-sticky note annotations.) My thinking it's, you know, maybe the boys don't want her to be better than them. That why they keep on, "No, you can't play, Jessica." (Points to words.) But that's how I am like, Who cares? Just play! I got schema for this one (Points to an asterisk drawn to symbolize a connection). I did that, you should see, when we do hockey in gym, all the girls be like, no I don't want to get hit with the stick, and I'm in there…whatever. I'm beat their... See, she, a…*muy buena jugadora de fútbol* [very good soccer player]. These characters (pointing to images of boys) they learn it. Mr. [P.E. teacher's name], he should know some girls are better than boys. Maybe he can read it in this book. I will ask him, like, *¿Conoces Jessica?* [Do you know Jessica?]. Ha, ha. You see Mr. [P.E. teacher's last name] reading like *Jessica's Big Day* (using an exaggerated tone and changing the name of the book's title).

Repairing word-level problems. Beyond sharing clear text connections, all four participants also identified unknown words or confusing sentences and implemented repair strategies to continue constructing meaning from text. Web-based tools (e.g., e-texts with words hyperlinked to online dictionaries) as well as peer discussion around the words targeted through the Frayer model graphic organizer were named as resources used to aid in repairing word-level problems. For example, after reading a passage about wind, Khaled pointed to a bold-font question at the beginning of the passage. The questions was, "What makes wind blow?" He began to share his thinking by explaining,

> It starts because the author says it's temperature. Wind from temperature. You know. I was thinking interesting because that's science (points to an exclamation point used to code the text). We measure it in different… spaces [connecting to a temperature-related activity completed in science class] Then. Well, I didn't know this one (points to the word "molecules") so I click it hear what says, but, you see the picture. Little parts. It already shows. So, I got that word. And then, this, I read this two times about air moves fast, and I know (points to vocabulary graphic organizer for "pressure") it is what I know on this. Air moving because pressure. It's the wind.

Questioning to address schema-level problems. When Ahmad, Jorge, Sofia, and Khaled recognized schema-level problems, they asked questions about concepts or events to which they could not directly relate. For example, Ahmad's response to the prompt, "Tell me what you were thinking as you read about the discovery [of a giant eyeball] on the beach" shows that he used and named strategies (i.e., predicting, making connections, asking questions) to persist with meaning making, and he continued to search for meaning beyond the text.

> At first I look at it and said, "Is this for real?" It look like a…legit from the news. But that picture of the eye…ball…I had to click these images. I predict shark first cuz it say Florida. They got salt water. Oooh [another student's name] scared. Gotta keep reading an' see though. So, here,

next, I thought what they said about "softball size." Good, 'cuz in the pic you can't really know…. So, they tell you. That's good. But back to, you know, my connection (points to a blurry symbol drawn on an e-sticky note), I was thinkin' who on "Sponge Bob" look like that. And then, I gotta question about it, too: Do squid have bones on they eye? It say this one do. So, shark right? But of this whole thing (scrolling through passage) they do not know what it is. I bet they do now on YouTube. I'm 'ma check it, can I?

Strategy Use during Maintenance Assessment

When multicomponent instruction faded into standard-instructional practices for a 3-week period, all four participants used strategies to earn scores that exceeded performance levels in the initial phase of the intervention (i.e., prior to the multicomponent phase). During this final phase of the intervention, instruction did not explicitly emphasize using comprehension-monitoring or text-coding strategies. However, participants continued naming use of specific strategies that had been taught explicitly in the previous phase of the intervention. For example, Jorge explained comprehension-monitoring strategies he used to read a passage that compared the way we might combat zombies in an apocalypse to how we can fight germs by following general health and safety tips.

At first…the title and the picture…I thought about this will be about zombies. You know (points to another student) he said he watches it [referring to a TV show about zombies]. I don't. My cousin watch it and they show a picture like this (gestures toward a still shot of an empty park bench). The author…it's…well. No…it's no zombies. *No enfermarse* [not getting sick]. It's like…he says at gym use hand sanitizer to kill germs. That's pretending it's zombies what I thought. Then, what the other rule the author says is drink water. I put the connection here (points to where he drew an asterisk). This reminds me of because [student name] was playing and crinkling loud the water bottle. It spilled so she said all the kids to put them in your locker. I ask the question, can we fight the germs with no water in here. (Points to where he used a sticky note and coded the text with a question mark.) Maybe…we ask her [the general education teacher] to see if we get the water bottles back?

Comprehension-Question Answering

Concurrent to increases in rubric scores depicting use of comprehension-thinking strategies, all participants demonstrated an increase in percentage accuracy for answering comprehension questions during the multicomponent phase of the intervention (see Figure 2). By posing comprehension questions, we evaluated literal and inferential interpretations of text against our own authoritative view of an "accurate" response. For all participants, increases in accuracy of inferential-question answering was more pronounced than increases in literal-question answering.
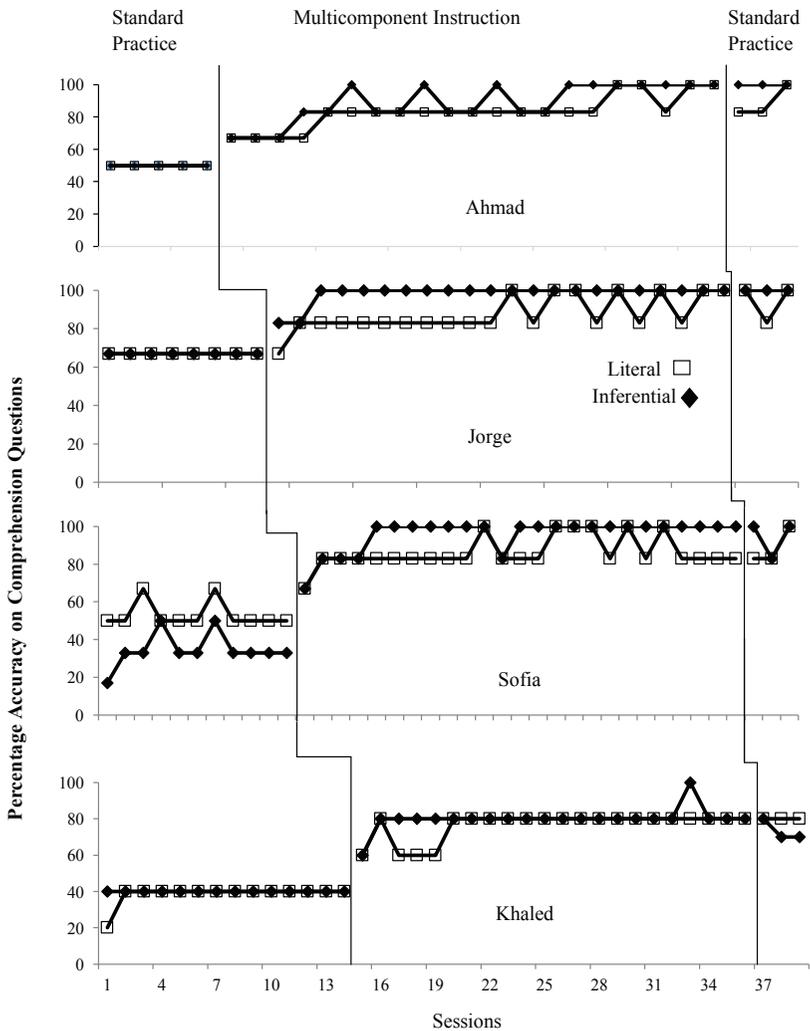
Figure 2. Percentage accuracy with answering literal and inferential comprehension questions.

Ahmad. Throughout the study, Ahmad's instructional reading level increased from L (mid-second grade level) to M (beginning third-grade level) during a 7-week period. His mean score with answering literal comprehension questions increased from 50 to 85%. His mean score with answering inferential comprehension questions increased from 50 to 90%. In the pre-baseline interview, Ahmad described an interest in reading nonfiction books about basketball or unsolved mysteries. He stated that he was not a very good or fast reader. In the post-intervention interview, he stated that he liked reading and that he thought he was an okay reader because he could "ask good questions" and "connect with what the author was writing" to make sense of text while he read.

Jorge. Throughout the study, Jorge's instructional reading level increased from M (beginning third-grade level) to O (mid-third grade level) during an 8-week period. Jorge's mean score with answering literal comprehension questions increased from 67 to 88% while his mean score with answering inferential comprehension questions increased from 67 to 98%. At the beginning of the study, Jorge offered a favorable impression of reading, stating that it was fun and important. He was able to identify several topics of interest that he would like to read about (e.g., basketball and soccer). Jorge stated that he was just an okay reader and that he did not like to read aloud. After the intervention, Jorge maintained a favorable attitude toward reading. He explained that he is a good reader because he can fix his mistakes by rereading, and he can make connections to help him understand more about the characters in books.

Sofia. Throughout the study, Sofia's instructional reading level increased from K (beginning second grade level) to L (mid-second grade level) during an 8-week period. Sofia's mean accuracy with answering literal comprehension questions increased from 53% during the baseline phase to 86% during the multicomponent phase of the intervention. Her mean accuracy with answering inferential questions increased from 35 to 96%. Prior to the initial baseline session, Sofia stated that she liked to read and was especially interested in books about butterflies. She said that she was just an okay reader and was worried because she made "lots of mistakes" when she read aloud in class. After the intervention, Sofia explained that to be a better reader she would "keep using strategies," which she then named (i.e., monitoring for meaning, asking questions, and making connections).

Khaled. Throughout the study, Khaled's instructional reading level increased from E (beginning first grade level) to G (ending first grade level) during an 8-week period. Khaled's mean accuracy with answering literal comprehension questions increased from 39 to 76% while his accuracy with answering inferential questions increased from 40 to 80%. At the beginning of the study, Khaled identified that he liked to read about math. He stated that he could read "so many, even millions, of words." After the intervention, he reported a favorable attitude toward reading, using words like "awesome" and "interesting" to describe the fiction and nonfiction texts he read in class. When asked questions about his self-efficacy as a reader, he stated, "I can read with expression and ask good questions."

Social Validity

After collecting posttest data, we provided a four-item, Likert-style survey to participants. We asked them to report their overall level of satisfaction with the texts, technology tools, and instructional setting. We also asked participants to rate how helpful they thought it would be for other students in fourth-grade classes to learn the same reading comprehension strategies. Participants rated a high level of satisfaction with the texts they read. They rated a moderate level of satisfaction with using mind-mapping applications and online dictionaries. They rated a high level of satisfaction with using Educreations to record and explain use of comprehension strategies and with using kidblog to interact with other students, teachers, and family members. All participants rated a high level of satisfaction with the helpfulness, setting, and size of the reading group.

Discussion

To evaluate the effects of the reading comprehension intervention, we primarily focused on the strategies that participants used to monitor the process of constructing meaning from text. We specifically collected data to identify any observable changes in the application of comprehension-monitoring strategies when four components were introduced as a package that combined explicit strategy instruction, the TRACK

mnemonic, web-based tools, and peer collaboration. We investigated observable changes in comprehension-monitoring behavior during the portion of the session in which participants read independently from instructional-level passages. We gathered data by posing reflective questions to elicit a self-report of strategy use. We rated responses according to set performance levels on the comprehension-thinking strategy rubric (Keene, 2006). This rubric was designed to sequence the development of comprehension-monitoring behavior across five stages. From the quantitative data we collected, scores gradually increased when multicomponent instruction was introduced. These subtle changes, in part, affirm the learning trajectory represented within the performance levels listed on the rubric. However, qualitative analyses of participants' transcribed responses to the reflective-conversation prompts reveal additional complexities about the development of comprehension-monitoring for ELs with LD in this study, which both complements and restricts interpretation of rubric scores. We further discuss developmental patterns in the sections that follow.

Agency and Self-Perceptions

Initially, participants' text connections appeared to reside at the surface level by anchoring to images or messages conveyed through words in only the title of the text. However, transcript data from baseline sessions showed that participants used language to talk about actions they would or could take to address self-identified needs that emerged from interacting with pictures or words in the titles. For example, after reading about tornadoes and making comments about images in the text, Khaled stated that he had not been present during a tornado drill and that he would need to find the evacuation map to see what the class should do if there were a tornado. Similarly, Ahmad expressed that he wanted to find a different book to learn what would happen if a Komodo dragon encountered a cobra. The decision to take immediate action to learn essential information or to abandon a book in the middle of reading signals that comprehension monitoring is taking place. The comprehension-thinking strategy rubric, however, did not award a points for these specific behaviors. Nevertheless, transcript data reflected that participants demonstrated a sense of agency during baseline sessions.

Castek and Beach (2014) posited that, in the context of literacy instruction, displaying competence with technology tools links to students' self-perceptions and sense of agency. In the multicomponent phase of the intervention, participants collaboratively interacted around text with peers and with family members (e.g., through mind maps and kidblog). In addition, they referred back to thoughts and reactions self-recorded on e-sticky notes. When these tools were infused into instruction, reflective conversations revealed that participants used text-level repair strategies to construct meaning from text, which also sparked self-recognition of needs. Participants began to communicate an intent to engage in interpersonal exchanges as a way to self-advocate for identified needs. For example, Maria half-jokingly expressed that she would share the story about a skilled, female soccer player with the P. E. teacher as a way to shift what she perceived as fixed or inaccurate views on gender and athletic ability. Also, based on the ideas presented in the passage he read about wellness and self-care, Jorge planned to advocate for the return of his peers' water bottles to the classroom in an effort to maintain health,. In addition, participants acquired new language with which to talk about themselves as strategic readers, using phrases such as, "I can question the author" or "I make connections to the text." In this study, participants demonstrated successful use of web-based tools but also reflected meaningful and successful collaborative exchanges with peers and family members around meaning constructed from text. The competencies that Ahmad, Jorge, Sofia, and Khaled demonstrated are reflective of "active citizenship in today's digital world" (Kiili, Mäkinen, & Coiro, 2013).

Summary of Findings

After participating in the intervention, Ahmad, Jorge, Sofia, and Khaled gave specific responses about what they needed to do to become better readers. The specific actions that they stated aligned with needs depicted in formative assessment data (i.e., scores and transcripts). Actions included using comprehension-monitoring behaviors that were targeted through explicit strategy instruction and peer collaboration, and that were captured through the screencasting application. Frequent interactive dialogue about reading comprehension strategies (e.g., monitoring for meaning and coding the text when using schema to ask questions or make connections) and the use of web-based tools supported each participant in developing the vocabulary needed to talk about themselves as readers. In addition, the multicomponent phase of the intervention led to increased strategy use, improvement in accuracy with answering literal and inferential comprehension questions, and demonstrations of a self-advocacy disposition.

Limitations

Several factors limit the findings of this study, and therefore cautious interpretations are urged. To begin with, ELs are a very diverse group of students, with unique strengths, needs, and language histories. Moreover, the way that disability status intersects with bilingualism or multilingualism is unique for each student. Therefore, the small number of participants and the unique characteristics of each participant included in this study limit the generalizability of the study's findings. Additional research investigations are needed.

Another limitation of the present study relates to the lack of component analysis within the phases of the intervention. Ultimately, we added a "treatment package" to standard-practice instruction. By introducing explicit strategy instruction, the mnemonic, web-based tools, and peer collaboration at once, we did not ascertain differential effects of each component. More research is needed to evaluate the efficiency and effectiveness of specific components.

In addition, the instruments used to assess strategy application and comprehension-question answering are limited. Measurement relied on direct observation with performance-based tasks, which yielded data that were ecologically valid. However, concerns with the reliability of these tools persist. Specifically, comprehension questions were not field-tested after being cross-checked by reading specialists, and rubrics allowed room for subjectivity to influence scoring. To address concerns with reliability, we collected IOA data in at least 25% of the sessions for each participant. In addition, data reflected four demonstrations of effect at four points in time.

Finally, standardized measures of reading achievement were not included as repeated measures throughout this study, which limits the ability to situate participants' performance within the context of what could be expected from same-age students (e.g., typically developing, monolingual students). Instead, we gathered authentic performance-based data to measure formatively the target behaviors on which the intervention's focus was isolated (i.e., application of comprehension strategies and comprehension-question answering). In using direct observation to gather data and to evaluate IOA, we offered an attempt to contribute initial, developmental data that may be referenced as a point of comparison in future studies that include ELs with LD.

Implications for Future Research

Given the limitations associated with this study, its findings are exploratory in nature. Additional research is needed to investigate effects for ELs with LD at all stages

of language proficiency. In this study, we identified that web-based tools were perceived favorably by participants. We used web-based tools to support participants' comprehension of instructional-level text. This allowed for the text to be comprehensible but did not offer the opportunity for grappling with on-grade-level texts, a demand apparent in standards-based assessments. To make on-grade-level text accessible to participants who have adequate listening comprehension, future research could incorporate components used in this study while also integrating use of assistive technology tools to support word-reading difficulties. For example, text-to-speech or screen reading support could be integrated into future studies when participants' listening comprehension levels align with on-grade level text.

One additional recommendation for future research relates to the mechanism through which we delivered strategy instruction. Through the explicit strategy instruction and the TRACK mnemonic, participants activated various comprehension strategies. Explicit instruction was provided to gradually release responsibility so participants could take ownership of the strategies. However, the onus was on the interventionist to remind participants to use the comprehension strategies. Self-regulated strategy development (SRSD) is one approach to equipping students with skills to self-regulate the use of strategies that has been implemented to address comprehension of expository text (Mason, Snyder, Sukhram, & Kedem, 2006). Future research should investigate the effectiveness of providing strategy instruction within an SRSD framework that is complemented by practices found to be promising for ELs with LD.

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