

# Literacy Learning Cohorts: Content-Focused Approach to Improving Special Education Teachers' Reading Instruction

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## Abstract

Two professional development (PD) models for teachers were compared on teacher and student outcomes. Special education teachers participated in Literacy Learning Cohorts (LLC), a PD innovation designed to improve content and pedagogical knowledge for providing reading instruction to upper elementary students with learning disabilities. The LLC, based on Desimone's (2009) framework, included 2 days of initial PD with follow-up meetings, coaching, and video self-analysis. A comparison group received only 2 days of PD. Results of independent *t* tests and analyses of covariance indicated that LLC teachers demonstrated significant change in instructional time allotted to, and quality of, word study and fluency instruction. LLC teachers also made significantly greater gains on the fluency knowledge measure as compared with the comparison group, but they did not differ in word study knowledge. Hierarchical linear modeling analyses showed that students of LLC teachers made significantly greater gains on word attack skills and decoding efficiency than did students of teachers in the comparison group.

Most students with learning disabilities (LD) experience pronounced and prolonged literacy struggles that negatively influence their achievement (Bender, 2008; Bridges & Catts, 2011). Their inability to rapidly decode words, particularly multisyllabic words, is a significant impediment to the comprehension of complex text (e.g., Dilberto, Beattie, Flowers, & Algozzine, 2009; Hudson, Torgesen, Lane, & Turner, 2012), shown in at least one study to be the strongest predictor of comprehension for adult students with LD (Mellard, Fall, & Woods, 2010). Notably, researchers have reported reading gains when intensive, explicit instruction in fluency and word study is provided (O'Connor et al., 2002; Wanzek, Wexler, Vaughn, & Ciullo, 2010), particularly for learning to recognize multisyllabic words (Sanchez & O'Connor, 2015). Although special education teachers often provide such

intensive reading instruction, many either do not have sufficient knowledge (Moats, 2009; Washburn, Joshi, & Binks-Cantrell, 2011) or lack sufficient pedagogical skill to enact their knowledge (Brownell et al., 2009). Compounding this problem, teachers are not typically engaged in carefully crafted, intensive collaborative professional development (PD) that helps to shape the pedagogical knowledge and skills needed to implement research-based

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instruction (Wei, Darling-Hammond, & Adamson, 2010).

*Literacy Learning Cohorts (LLC) is a PD innovation designed to improve special education teachers' content and pedagogical knowledge for providing reading instruction to upper elementary students with LD.*

The few PD studies in general and special education support the conclusion that teachers can learn to provide systematic, research-based instruction if they receive PD support that incorporates several key characteristics: (a) alignment with teachers' and schools' efforts to improve teaching and learning, (b) a focus on a few key ideas and strategies, (c) concrete ideas for implementing strategies, (d) opportunities to collaboratively analyze the effectiveness of implementation efforts in terms of student performance, and (f) varying levels of implementation assistance depending on individual teacher need (Gersten, Dimino, Jayanthi, Kim, & Santoro, 2010; Klingner, 2004; McCutchen, Green, Abbott, & Sanders, 2009). In special education, researchers have emphasized a practice-focused approach to PD (see review, Pugach, Blanton, Correa, McLeskey, & Langley, 2009) but have paid less attention to the foundational knowledge that teachers need to develop their skills as reading or writing teachers (e.g., Boudah, Blair, & Mitchell, 2003; Greenwood, Tapia, Abbott, & Walton, 2003). An exclusive focus on implementing evidence-based practice that emphasizes changing teachers' behavior but omits the development of necessary knowledge does not always promote teachers' performance on more complex tasks (Mayer, 2009). Zaslow, Tout, Halle, and Starr (2011), in their review of early literacy PD studies, concluded that knowledge-focused efforts combined with practice-focused efforts were effective in improving teachers' ability to provide reading instruction. For example, Neuman and Cunningham (2009) found that teachers who participated in a college course on language and literacy development gained in their knowledge

of language but did not know how to implement that knowledge. In contrast, teachers in a college course who received coaching for implementation improved their instructional practice and achieved better student achievement gains. Combining knowledge- and practice-based approaches seems to facilitate the integration of teachers' content and pedagogical knowledge.

We report on a Goal 2 study supported by the Institute of Education Sciences. Goal 2 studies support development of innovative practices, including PD innovations. Teachers were randomly assigned to two PD conditions to determine the effects of a comprehensive PD approach grounded in Desimone's (2009) framework for effective PD as compared with a 2-day intensive training. Literacy Learning Cohorts (LLC) is a PD innovation designed to improve special education teachers' content and pedagogical knowledge for providing reading instruction to upper elementary students with LD. The purpose of the LLC project was to develop, implement, and demonstrate the effect of a PD model on teacher and student outcomes. The content of the LLC focused on word study (i.e., decoding and structural analysis) and fluency instruction because these foundational components of reading challenge individuals with LD into adulthood (e.g., Mellard et al., 2010) and because it would be impractical for teachers to learn and apply in a single year the knowledge and skill needed to provide effective, comprehensive reading instruction.

## **Theoretical and Conceptual Framework Supporting the LLC**

The LLC design was based on Desimone's (2009) conceptualization of effective PD: PD focused on the content that teachers must know to teach a subject and the pedagogy for enacting that content. Desimone's PD framework emphasizes five elements of PD: specific content focus, active learning, collective participation, sufficient duration, and coherence. In addition to incorporating these five elements, we adapted Desimone's framework to include opportunities for more intensive,

individualized support. We review studies on these elements, paying specific attention to PD studies designed to improve teachers' knowledge for teaching reading, their instructional practice, and the achievement gains of struggling readers.

### **Content Focused**

Research is beginning to accumulate that demonstrates that PD innovations designed to enhance teachers' knowledge for teaching content in reading, mathematics, and science result in positive gains in teacher knowledge, instructional practice, and student achievement (e.g., Desimone, Smith, & Phillips, 2013; Gersten et al., 2010; Heller, Daehler, Wong, Shinohara, & Miratrix, 2012). The majority of PD research focused on reading involved experimental and quasi-experimental studies designed to improve teachers' knowledge and skill for teaching reading. These studies established effects of content-focused PD on teachers' knowledge and instructional practice and students' reading achievement (e.g., Carlisle & Berebitsky, 2010; Gersten et al., 2010; Greenleaf et al., 2011; McCutchen et al., 2009; Neuman & Cunningham, 2009). It is important to note that PD in these studies was implemented by researchers or highly trained coaches supervised closely by researchers.

Garet and colleagues (2008), however, conducted a PD innovation scale-up study that involved a content-focused PD institute and ongoing coaching. Teachers in the content-focused PD institute plus coaching were compared with teachers in two other groups: those involved only in the PD institute and those who received training in only the reading curriculum. The two PD institute conditions had a positive effect on teacher knowledge and instructional practice as compared with the curriculum-only condition. There was no significant difference among the three treatments on student achievement. Perhaps the state-administered assessments used by Garet et al. were not as sensitive to student achievement gains as the individually administered assessments used in other studies of

coaching, or coaching was not implemented as effectively as in other studies (e.g., Carlisle & Berebitsky, 2010; McCutchen et al., 2009).

### **Active Learning Opportunities**

For teachers to enact content knowledge, they need opportunities to actively engage with the content (e.g., Neuman & Cunningham, 2009). PD innovations focused on reading that provided teachers with active learning opportunities have produced changes in teacher knowledge or instructional practice and changes in students' reading achievement (e.g., Gersten et al., 2010; McCutchen et al., 2009). Many studies have included activities that helped teachers (a) analyze student thinking and other student data sources, (b) understand what effective practice looked like using video models or in classroom models, (c) plan instruction, (d) analyze their instructional practice, and (e) discuss the strategy implementation process (Carlisle & Berebitsky, 2010; Garet et al., 2008; Gersten et al., 2010; McCutchen et al., 2009; Neuman & Cunningham, 2009). These opportunities also have been provided over long periods. For example, McCutchen et al. (2009) used a 10-day summer institute combined with three 1-day follow-up sessions and literacy coaching to support third- through fifth-grade teachers in developing their knowledge of (a) phonology, phonemic awareness, and morphology; (b) the role of that knowledge in vocabulary development, reading comprehension, and composition; and (c) how to implement that knowledge during reading instruction. Large effects were found for teachers' knowledge and instructional practice, as well as student achievement.

### **Collective Participation Opportunities**

Collective participation opportunities are structures that afford teachers opportunities to interact with others as they learn, and they seem to support the development of teachers' knowledge and instructional practice. When teachers work in collaborative arrangements (e.g., in a study group), they have opportunities to anchor what they are

learning in PD into the context of their instruction, curriculum, and classroom (Desimone, 2009). Studies of teacher study groups, teacher networks, and coaching to improve literacy instruction have demonstrated that teachers—and, in turn, their students—profit from opportunities to learn, including discussions about (a) effective strategies for teaching content, (b) analysis of student thinking and performance, (c) observations of models of effective instruction, and (d) feedback on their instruction (e.g., Carlisle & Berebitsky, 2010; De La Paz, Malkus, Monte-Sano, & Montanaro, 2011; Gersten et al., 2010; McCutchen et al., 2009). Further, several of these studies demonstrated that increases in implementation supports, particularly in the form of coaching, yield stronger achievement gains for students, as opposed to when less support is provided (Biancarosa, Bryk, & Dexter, 2010; De La Paz et al., 2011).

### **Duration**

The time spent in PD activities is foundational but insufficient for improving teacher practice and student achievement. In a review of PD research, Yoon, Duncan, Lee, Scarloss, and Shapley (2007) found that substantial PD, lasting on average 49 hr, was effective in raising participants' student achievement; yet, precisely how much time is needed to promote teacher learning is not clear. For instance, Biancarosa et al. (2010) showed that PD accounted for increasing proportions of variance in student reading outcomes for each additional year that teachers spent in PD, and De La Paz et al. (2011) showed that participation in more than 30 hr of PD was associated with greater gains on student writing outcomes than participation in less than 30 hr. Time alone, however, is not a good predictor of PD efficacy (Feng & Sass, 2013; Harris & Sass, 2011). Teachers also need time for extended active learning opportunities to work with their knowledge (Gersten et al., 2010; McCutchen et al., 2009).

### **Coherence**

How well aligned PD activities are with state assessments and standards as well as other

aspects of teachers' work seems to characterize the effectiveness of these activities. Activities that are connected to teachers' goals for student learning, teachers' curriculum, other PD experiences, state assessments, and current reform efforts are likely to improve teacher knowledge and skills (e.g., Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Phillips, Desimone, & Smith, 2011). Misalignment among PD, accountability demands, curriculum, and content standards can interfere with the ability of teachers to implement what they are learning (Penuel, Fishman, Gallagher, Korback, & Lopez-Prado, 2009).

Studies of effective PD have included innovations that incorporated multiple supports to help teachers integrate newly acquired knowledge and strategies into available curriculum materials (e.g., Carlisle & Berebitsky, 2010; Gersten et al., 2010; Hindman & Wasick, 2012; McCutchen et al., 2009). For example, Gersten et al. (2010) used Desimone's (2009) framework as the foundation for their teacher study group PD innovation designed to help first-grade teachers in Reading First schools improve their vocabulary instruction. The researchers addressed the coherence principle by helping teachers (a) integrate into their curriculum the knowledge that they were acquiring and (b) respond to school, district, and state initiatives that required them to use research-based strategies. Although it is impossible to isolate the impact of coherence, studies attending to this principle—with one exception (Garet et al., 2008)—have demonstrated a positive impact on teacher and student outcomes.

### **Individualized Support**

Teachers benefit differentially from PD efforts and likely need individualized support as follow-up to PD (Klingner, 2004). According to Brownell and colleagues (Brownell, Adams, Sindelar, Waldron, & vanHover, 2006; Brownell et al., 2014) and Dingle and colleagues (Dingle, Brownell, Leko, Boardman, & Haager, 2011), some general and special education teachers learn to implement strategies

easily, whereas others require extensive assistance to achieve successful implementation: A combination of individual qualities (e.g., knowledge of content and teaching) and context qualities (e.g., adaptability of the curriculum) influenced teachers' implementation of new strategies.

For example, Brownell et al. (2014) studied contextual and personal characteristics that influenced learning and classroom practice of five elementary special education teachers in a literacy-focused PD effort that included a content-focused institute, teacher study groups, and follow-up coaching. Using qualitative interviews and observations of classroom performance combined with quantitative assessments of instructional practice, these researchers found that teachers who learned the most demonstrated integrated knowledge and practice; that is, they could better describe why they selected particular interventions, how those interventions would support their students, and why the interventions were improvements over their current instruction. Compared with teachers who learned less, they also used the interventions to change their instruction in more comprehensive ways, as demonstrated on quantitative measures. Teachers' propensity to analyze their instruction along with their students' needs appeared to be the strongest influence on what teachers learned and what changes made to their instruction, although individual teacher qualities and contextual factors were also influential (Brownell et al., 2014). Differences among teachers suggested a need for differentiated PD support, particularly support that helps them improve their ability to analyze their instruction and student learning.

One PD strategy assumed to provide individualized support to teachers is coaching (Kretlow & Bartholomew, 2010), although we were unable to identify studies that examined the direct relationships of differentiated coaching based on teachers' need and teachers' instructional practice. One qualitative study of Reading First coaches showed that coaching is important for improving individual teachers' understanding of effective reading strategies

and their willingness to implement them. Coburn and Woulfin (2012) found that coaches helped individual teachers learn new instructional approaches and integrate them into their existing practices by persuading and even pressuring teachers to engage in specific strategies, as well as by helping them to distill what was the most essential to implement. Moreover, through classroom observations, Coburn and Woulfin learned that how coaches worked with teachers influenced what teachers ultimately decided to do in the classroom. Their study supports the assumption that coaching is a viable approach for addressing teachers' individual learning needs.

## Purpose and Research Questions

Studies of PD in literacy in general education have supported Desimone's (2009) framework and have been methodologically and conceptually strong. Most studies have employed multilevel analysis of student achievement data, and many have documented the effect that PD had on teacher outcomes. Although content-focused PD efforts that are multifaceted seem to promote successful outcomes, research on content-focused literacy PD efforts are limited in general education and absent in special education. In the special education literature, we identified only two qualitative studies where a content-focused PD approach was used to improve the literacy knowledge and practice of special education teachers (Brownell et al., 2014; Dingle et al., 2011). Although these studies illuminated individual and contextual factors that promoted special education teachers' learning, they did not assess the impact of content-focused PD on teachers' knowledge and instructional practice and student achievement. As a consequence, there is no research that has demonstrated the promise of content-focused PD for improving special education teachers' knowledge and instruction. Our study is the first to assess the efficacy of Desimone's (2009) framework for developing special education teachers' knowledge and instruction in the area of reading. Specifically,

we examined the efficacy of Desimone's framework as combined with coaching and video self-reflection that focused on individual teachers' learning needs.

*Although content-focused PD efforts that are multifaceted seem to promote successful outcomes, research on content-focused literacy PD efforts are limited in general education and absent in special education.*

The purpose of our project was to determine the LLC intervention's potential for improving special education reading instruction and student achievement. We compared teachers who participated in the full LLC intervention with teachers who received only the 2 days of initial PD. We addressed the following research questions:

1. Did LLC teachers demonstrate higher posttest means than those of PD-only teachers on their use of evidence-based practices (word study, word-level fluency, and fluency with connected text) and use of general effective instructional principles?
2. Did teachers participating in the LLC demonstrate higher posttreatment scores than those of teachers participating in the PD-only group on knowledge for teaching word study and fluency?
3. Did students of teachers in the LLC demonstrate higher posttest scores than students in the PD-only condition on measures of word identification, word attack, and fluency with connected text, after accounting for within-classroom variance and students' pretest means?

## Method

We used an experimental randomized block design to compare LLC and PD-only teachers on (a) the quality of teacher practice, (b) use of evidence-based practice, (c) teacher knowledge, and (d) student outcomes.

## Setting

Schools located in four districts in three states participated in the study during the 2009–2010 school year. Two districts were in Florida. The first Florida district included students whose free or reduced-price lunch (FRL) percentage was 48.57%, and participant teachers taught in 6 of 24 schools. In the second Florida district, the FRL percentage was 33.70%, and participants taught in 7 of 26 schools. In the Colorado district, the FRL percentage was 32.40%, and participants taught in 8 of 29 schools. In the California district, the FRL percentage was 69.94%, and participants taught in 8 of 16 schools. The four districts' FRL percentages ranged from 32.40% to 69.94%; the average FRL percentage was 46.15%, which was similar to the national percentage at the time the study took place, 46% (National Center for Education Statistics, 2011).

## Participants

**Teachers.** All eligible special education teachers in the four school districts were invited to participate. Eligible teachers included special educators who taught reading to third-, fourth-, and fifth-grade students with LD in small groups for at least 4 days per week. The final sample included 25% to 50% of eligible teachers in each district. Teachers who indicated that they were willing to participate, met the above criteria, and signed consent forms, as dictated by the institutional review board, were included until study slots were full. Slots were limited by the funding available. Teachers ( $N = 42$ ) from two school districts in Florida ( $n = 21$ ), one in Colorado ( $n = 11$ ), and one in California ( $n = 10$ ) participated. Ninety-five percent of the teachers in the study were female ( $n = 40$ ) and White. Teachers had 1 to 41 ( $M = 13.52$ ) years of teaching experience. Forty teachers were certified in special education, and three held reading/literacy certifications. Eighteen teachers had master's degrees: 15 in special education and 3 in reading/literacy. The LLC group ( $n = 22$ ) and PD-only group ( $n = 20$ ) were similar in

terms of gender, race, degrees, certification areas, and experience. Participants reflected national statistics for special education elementary teachers on race, gender, and attainment of master's degrees for 2008 (U.S. Department of Education, 2013).

**Students.** Teachers in both conditions selected one of their reading groups to participate in the study. Groups included students with LD in the third, fourth, or fifth grade. There were 170 students that participated in two rounds (beginning and end of school year) of student measurement: 94 were taught by LLC teachers and 76 by PD-only teachers. Groups had similar demographic characteristics. More than half the students were males and received FRL, and almost half the students were White.

### *Experimental Design*

Participants were assigned to groups by randomized block assignment (Raudenbush, Martinez, & Spybrook, 2007) at the school level to control for differences in school demographics. Participants' schools were ranked according to the percentage of students receiving FRL and assigned to one of two conditions (LLC or PD only); schools' FRL percentages were similar in both study conditions.

### *LLC Innovation*

The LLC was designed to deepen special education teachers' knowledge of how to teach reading using evidence-based strategies, specifically strategies for teaching word study and fluency at the word and passage levels. Each feature of Desimone's (2009) framework was addressed in the LLC innovation.

**Content focused.** A PD institute offered in the second month of school for LLC and PD-only teachers provided foundational knowledge about (a) English phonology and orthography underlying word analysis skills, (b) strategies for teaching and assessing word study and fluency, and (c) assessment practices for individualizing instruction and monitoring progress. Teachers also had opportunities to see

strategies demonstrated and practice them. PD content included (a) segment to spell (a strategy for helping students learn the alphabetic principle), (b) syllable types and decoding rules that could be used to support students' acquisition of the syllable types, (c) decoding rules for multisyllabic words, (d) activities for finding roots and affixes, (e) a multisyllabic decoding strategy that focused on decoding and understanding words, (f) fluency strategies (e.g., repeated reading, self-recording progress, and reading for prosody), and (e) effective instructional principles (e.g., explicit instruction).

LLC teachers also received a resource manual and book about word identification to support their content knowledge. The manual included a scope and sequence for word study and fluency, instructional activities, word lists, and additional resources. It supported teachers in selecting appropriate words for instruction, teaching decoding rules, sequencing multisyllabic word analysis strategies, and selecting activities for instruction. The published book (O'Connor, 2007) was aligned with content provided in the PD institute.

**Active learning opportunities, collective participation, and coherence.** Following the PD institute, LLC teachers participated in six monthly cohort meetings designed to assist them in implementing newly learned content from the PD institute. These small group meetings (five or six teachers) were led by expert coaches. The first was a half-day session that occurred approximately 2 weeks after the PD institute. It supported teachers in analyzing their students' diagnostic and progress-monitoring information, setting learning goals for them, and developing an action plan for implementing PD knowledge and strategies as well as practicing those strategies. Five 90-min meetings occurred after school during months 3 to 8.

**Individualized support.** LLC teachers were observed by expert coaches after four monthly cohort meetings. These observations supported implementation of LLC strategies and provided teachers with individualized

feedback. The coach for each cohort viewed four classroom observations for each teacher and met with teachers individually after each observation. For the observations, teachers were asked to implement strategies from the PD or O'Connor (2007) book that were appropriate for their students. Observations were video recorded, and teachers and coaches watched and reflected on video recordings using a rubric. Then teachers met with their coaches to discuss the lesson, agree on areas of instruction that needed further development, and plan next steps (approximately Months 2, 4, 6, and 8).

There were two coaches in California, three in Colorado, and two in Florida. Six coaches had or were earning doctoral degrees in reading or special education, and all had extensive experience in teaching, coaching, and reading intervention and research.

**Treatment integrity.** For consistency, slides with detailed speaker notes were used at each site. Integrity of the intervention was determined by having observers at each site monitor PD delivery according to the speaker notes. Observers alerted presenters if something was missed. The initial PD was also videotaped, and segments were spot-checked for consistency across sites. The presenters developed detailed agendas for the monthly small group LLC meetings; each site delivered the same content in the same way at roughly the same time. Two project researchers were present at each meeting, one (the coach) to facilitate and one to ensure adherence to the agenda. For individual teacher observations, all coaches followed a protocol.

### Teacher Measures

Dependent measures were selected to assess gains in teachers' instructional quality and their implementation of evidence-based practice. Measures were administered at pretest before the PD and at posttest after the last coaching observation.

**Classroom observation procedures.** All teachers' classroom practices were assessed through

video-recorded observations during instruction in word study and fluency, as scheduled with teachers in advance. During observations, teachers taught groups ranging from two to 10 students for 20 to 90 min. LLC teachers were observed four additional times throughout the school year as part of the LLC model.

**Quality of instruction observation tool.** To assess the quality of teachers' implementation of evidence-based practices in word study (including decoding and structural analysis) and fluency instruction, we developed an observation tool with three scales to measure word study (nine items), word-level fluency (two items), and fluency with connected text (three items; see Figure 1). Items for the tool were designed according to findings from research on quality instruction in word study and fluency for students with disabilities in the upper elementary grades (Brownell et al., 2009) and revised per current research on word study and fluency (Hudson, Lane, & Pullen, 2005; O'Connor, 2007; Rasinski, Blachowicz, & Lems, 2006; Weiser & Mathes, 2011).

Teachers were rated for each item on a 6-point Likert scale, where 1 indicated that the practice was not observed or poorly executed and 6 indicated a high level of proficiency. Extensive scoring criterion was provided for each anchor of the scale. Prior to using the observation tool in this study, we examined two research assistants' ability to achieve scoring reliability. Alpha coefficients for two independent raters were  $>.92$  for all three instruments. Alpha coefficients for each scale were also high: .98 for word study, .91 for word-level fluency, and .95 for fluency with connected text.

After training on the tool and prior to independent scoring, raters scored two videos not in the sample and achieved agreement  $\geq 60\%$  with anchor ratings established by experts. Agreements were computed by dividing the number of items rated the same by the total number of items. This level of interrater agreement is consistent with other studies of high-inference classroom observation tools

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### Word Study

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The teacher *selects words* that are appropriate for instruction.

- Words support the pattern or strategy being taught
  - Words encourage students to actively employ decoding skills
  - Words are challenging but not too difficult (they also must be sufficiently challenging; if students are easily handling the words, then the teacher should select more challenging ones)
  - Words that do not follow the pattern or strategy are limited
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### Word Level Fluency

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The teacher engages in quality *sight word/word pattern practice*:

- Words/word patterns selected are appropriate in level
  - Number of words/word patterns practiced are appropriate
  - Orthographic patterns, spelling, and/or phonograms are highlighted
  - Activities include opportunities for automatic/quick response
  - Regular and irregular sight words are included
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### Fluency with Connected Text

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During fluency practice reading text, the teacher:

- Establishes a purpose for instruction and practice (accuracy, rate *and/or* prosody)
  - Demonstrates or reminds students how to read with accuracy, rate or prosody
  - Uses appropriate text given the level of teacher/peer support provided during the lesson
  - Uses text that is of the appropriate length for students' level
  - Uses fluency practice activities that are research-based
  - Has students actively reading (not passively listening)
- 

**Figure 1.** Quality of teachers' instruction sample items.

where large numbers of raters are involved (e.g., Bill & Melinda Gates Foundation, 2014). Because high levels of interrater agreement would be difficult to achieve, we paired raters for this study who rated each video independently. Agreement between paired raters overall was >96% for each question. The average of raters' independent ratings was used as the dependent variable.

**Time spent in Recommended Practices Time Sampling Instrument.** We developed a low-inference instrument to identify time allocated to research-recommended practices in word study, word-level fluency, and fluency with connected text instruction (see Figure 2). Raters watched observation videos in 3-min intervals, stopping the video after each interval to record research-recommended practices observed. For example, raters recorded the teaching of word study skills, such as classification and manipulation of letter sounds (e.g., organizing words with diphthongs, spelling

words where one or two letters change), blending and segmenting with letter sounds, and structural analysis. For word-level fluency, raters recorded teachers' use of strategies that focused on rapid practice with words while emphasizing orthographic patterns. For fluency with connected text, teachers' use of echo reading, choral reading, partner reading, and repeated readings was recorded. Raters trained to 100% agreement with one another before rating.

**Knowledge for teaching fluency and word study.** To measure teachers' knowledge for teaching reading fluency, we used a five-item open-answer survey that had been validated with general education teachers (Lane et al., 2009); specifically, teachers' knowledge was a significant predictor of first-grade students' decoding growth and second-grade students' oral reading fluency growth. Teachers defined fluency and described practices for teaching fluency. Each response was scored by two

Field Notes			
Curriculum		Design	
Instruction	<input type="checkbox"/> Great Leaps <input type="checkbox"/> Language <input type="checkbox"/> Read Naturally	<input type="checkbox"/> Success For All <input type="checkbox"/> Rewards <input type="checkbox"/> Reading Mastery <input type="checkbox"/> Soar to Success <input type="checkbox"/> Open Court <input type="checkbox"/> Trophies	<input type="checkbox"/> Wilson <input type="checkbox"/> Orton Gillingham <input type="checkbox"/> Teacher Created <input type="checkbox"/> Child managed <input type="checkbox"/> Peer managed
Word Study	<input type="checkbox"/> Sound cards <input type="checkbox"/> Manipulation <input type="checkbox"/> Reading words <input type="checkbox"/> Analogizing	<input type="checkbox"/> Spelling <input type="checkbox"/> Discrimination <input type="checkbox"/> Chunking <input type="checkbox"/> Affixes for decoding	<input type="checkbox"/> Blending <input type="checkbox"/> Word building <input type="checkbox"/> Syllabification <input type="checkbox"/> Affixes for meaning
Fluency	<input type="checkbox"/> Rate <input type="checkbox"/> Nonsense words <input type="checkbox"/> Irregular words	<input type="checkbox"/> Accuracy <input type="checkbox"/> Decodable words <input type="checkbox"/> Letter sounds <input type="checkbox"/> Inflected endings	<input type="checkbox"/> Spelling <input type="checkbox"/> High-frequency words <input type="checkbox"/> Word patterns <input type="checkbox"/> Connected text
PA/Decoding		Comments	
Strategy		<input type="checkbox"/> Segmenting <input type="checkbox"/> Onset-rime <input type="checkbox"/> Syllable types <input type="checkbox"/> Cognitive strategy	<input type="checkbox"/> PA in isolation <input type="checkbox"/> PA tied to letters <input type="checkbox"/> Basic decoding <input type="checkbox"/> Letter patterns <input type="checkbox"/> Multisyllabic decoding
Reading Text			

**Figure 2.** Time spent in Recommended Practices Time Sampling Instrument PA = phonological awareness.

raters using a rubric provided by Lane et al. (2009); rater agreements were >90% across all items.

To measure teachers' knowledge for teaching word study, we used a modified version of Phelps and Schilling's (2004) validated Content Knowledge for Teaching Reading Survey administered at pre- and posttest. This survey includes questions related to two kinds of pedagogical knowledge critical for teaching reading: knowledge of students and content and knowledge of teaching and content. We modified the survey to include eight instructional scenarios and 44 related items focused on teaching word study. The alpha coefficient for data in this study was .50.

### **Student Measures**

Student data sources were selected to align with the areas of focus in the PD. Student gains in decoding, decoding efficiency, and oral reading fluency were assessed before the PD (Month 2 of the school year) and after the PD (Month 10 of the school year). Assessors were retrained for each administration and monitored in the field. The student tests included two subsections of the Woodcock Reading Mastery Test-Revised (Woodcock, 1998) and the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Good & Kaminiski, 2002) assessment of fluency with connected text and word reading. Student testing was conducted during a 3-week window at all sites. Trained testers individually assessed students. Testers participated in a full day of training before the first test administration and a half-day of training before each subsequent round of test administration. Testers were observed in the field by trainers to ensure fidelity. Trainers also verified scoring.

**Woodcock Reading Mastery Test-Revised.** The Word Identification and Word Attack subtests were administered to assess decoding. The Woodcock Reading Mastery Test-Revised is a norm-referenced, individually administered wide-range achievement test that is appropriate for students with LD. Internal reliabilities

for the administered subsections ranged from .89 to .97.

**Dynamic Indicators of Basic Early Literacy Skills.** The Oral Reading Fluency (ORF) test was administered to assess fluency with connected text. The Nonsense Word Fluency subtest was used to assess decoding efficiency. For the Nonsense Word Fluency, students were scored on correct letter-sound correspondences and on words read correctly. These two Nonsense Word Fluency scores have been used to predict performance on decoding efficiency as measured by the Test of Word Reading Efficiency and on reading rate and accuracy as measured by the DIBELS ORF (Hagan-Burke, Burke, & Crowder, 2006; Harn, Stoolmiller, & Chard, 2008). Grade levels for the ORF test administration were determined for each student through the Woodcock Reading Mastery Test-Revised Word Identification as a starting point during the test administration. From that point, the grade level at which the student was able to read between 25 and 80 words correctly was determined by trial, and the student read three passages at that level. At each subsequent administration of the ORF, students read three passages at that same grade level. The median score was used for analysis.

### **Data Analysis**

Teacher and student data were analyzed to compare the LLC and PD-only groups. Student data were analyzed with multilevel analysis to account for the nesting of students in teachers.

**Teacher measures.** Separate analyses were conducted for the three scales of the Quality of Instruction Observation Tool and for each variable on the Time Spent in Recommended Practices Instrument (i.e., number of time intervals for word study, word-level fluency, and fluency with connected text). For each variable, the Treatment (LLC vs. PD only)  $\times$  Pretest interaction was tested first. If the interaction was significant, the treatment effect was tested by comparing estimated conditional

posttest means, defined at the grand mean for the pretest, for both groups. If the interaction was nonsignificant, a model excluding the interaction term was estimated. If the pretest significantly predicted the posttest, the treatment effect was tested by comparing adjusted means for the two groups. If the pretest did not significantly predict the posttest, the pretest was deleted from the model, and the treatment effect was tested by comparing posttest means for the two groups through an independent samples  $t$  test. Directional tests of treatment effects were conducted. Reported  $p$  values for treatment effects are upper tailed.

To compare mean differences for LLC and PD-only teachers on the two knowledge measures, separate analyses of covariance were conducted. The analysis steps described in the preceding paragraph were also used for the teacher knowledge variables.

**Student measures.** Separate multilevel analyses of variance were conducted for each variable. In all models, class mean pretest achievement and class mean-centered pretest achievement were covariates. An initial model included the interaction between class mean pretest achievement and treatment and between class mean-centered pretest achievement and achievement. Kenward-Roger degrees of freedom (Kenward & Roger, 1997) were used for tests of fixed effect. The within-class intercept and slope were assumed to vary across classes. The interactions were not significant for the five achievement variables and were deleted from the models. Thus, the final model included treatment (LLC vs. PD only) and the two covariates. Both covariates were significantly related to posttreatment achievement for all five achievement variables. Directional tests of treatment effects were conducted. Reported  $p$  values for treatment effects are upper tailed. Cohen's  $d$  was estimated with the LLC and PD-only group-adjusted means from the final model, and the between-class standard deviation was estimated by using a model that included only the dummy-coded treatment variable. The between-class standard deviation was used because the treatment was implemented at the class level.

## Results

We report results of analyses for the different research questions to determine the efficacy of the LLC model. These results are reported first for teacher outcomes and then for student outcomes.

### *Quality of Word Study, Word-Level Fluency, and Fluency With Connected Text Instruction*

**Word study.** LLC teachers and PD-only teachers began the study with no significant difference on the Quality of Instruction Observation Tool Word Study Scale ( $M = 28.05$ ,  $SD = 12.99$ , and  $M = 27.36$ ,  $SD = 12.07$ , respectively). The Treatment  $\times$  Pretest interaction,  $t(36) = 2.14$ ,  $p = .04$ , was significant. The test of the treatment effect was significant,  $t(36) = 2.50$ ,  $p = .02$ , with conditional means of 35.25 and 26.83 for the LLC and PD-only teachers and with Cohen's  $d$  equal to 0.70. The interaction indicated that the effect of the LLC model was greater for teachers who began the study with lower observed quality of word study instruction. For teachers who began the study with observed quality of word study instruction one standard deviation below the grand mean, there was a significant LLC effect,  $t(36) = 3.29$ ,  $p = .00$ , and a large effect size ( $d = 1.31$ ). For LLC teachers one standard deviation above the grand mean at pretreatment, there was no significant effect,  $t(36) = 0.21$ ,  $p = .83$ , and  $d = 0.09$ .

**Word-level fluency.** There was no significant difference between the posttreatment means of LLC teachers ( $M = 5.73$ ,  $SD = 2.69$ ) and PD-only teachers ( $M = 5.06$ ,  $SD = 3.20$ ) on the Quality of Instruction Observation Tool Word-Level Fluency Scale,  $t(38) = 0.72$ ,  $p = .48$ , and the treatment effect was small to moderate ( $d = 0.23$ ).

**Fluency with connected text.** There was no significant difference between LLC and PD-only teachers at pretest on the Quality of Instruction Observation Tool Fluency With Connected Text Scale. Teachers participating in the LLC

model had a mean quality rating of 9.59 ( $SD = 3.08$ ), whereas PD-only teachers had a mean of 7.94 ( $SD = 3.65$ ). Pretest scores were not significantly related to post-LLC scores,  $t(37) = 0.89$ ,  $p = .35$ . LLC teachers had significantly higher posttreatment means ( $M = 11.43$ ,  $SD = 3.35$ ) on observed quality of practices in fluency with connected text as compared with PD-only teachers ( $M = 6.19$ ,  $SD = 3.62$ ), and these differences were significant,  $t(38) = 4.70$ ,  $p = .00$ . Additionally, effect of LLC was large ( $d = 1.51$ ).

### *Time Spent Engaged in Evidence-Based Practices*

**Word study.** At pretest, there was no significant difference between groups on the Time Spent in Recommended Practices Time Sampling Instrument in the number of time intervals that included word study. LLC teachers were observed using word study practices for a mean of 10.39 intervals ( $SD = 7.71$ ) and PD-only teachers, a mean of 12.76 intervals ( $SD = 10.46$ ). At posttest, an independent samples  $t$  test revealed no significant difference between the LLC and PD-only groups,  $t(39) = 1.15$ ,  $p = .128$ , and the effect of treatment was moderate ( $d = 0.36$ ). The mean number of time intervals for word study instruction was 12.36 for the LLC teachers ( $SD = 6.81$ ) and 9.65 ( $SD = 8.43$ ) for the PD-only teachers.

Further analysis was completed for each aspect of word study instruction (structural analysis, blending, segmenting, and classification and manipulation). The analysis of posttreatment mean differences on number of time intervals spent in structural analysis indicated that the LLC teachers ( $M = 7.36$ ,  $SD = 8.15$ ) were significantly greater than PD-only teachers ( $M = 3.70$ ,  $SD = 6.91$ ) on this variable,  $t(39) = 1.92$ ,  $p = .03$ ,  $d = 0.59$ . LLC ( $M = 0.95$ ,  $SD = 2.46$ ) and PD-only ( $M = 0.58$ ,  $SD = 1.61$ ) teachers were not significantly different on time spent on blending with letters,  $t = 0.77$ ,  $p = .22$ ,  $d = 0.25$ . We did not analyze segmenting, because so few teachers used it during the postobservation. Based on the model with the interaction term, LLC ( $M = 1.32$ ,  $SD = 2.51$ ) and PD-only

( $M = 1.00$ ,  $SD = 1.70$ ) teachers were not significantly different on instruction that requires students to classify or manipulate sounds,  $t(37) = 1.42$ ,  $p = .08$ ,  $d = 0.43$ . However, there was a significant interaction effect,  $t(37) = 2.54$ ,  $p = .02$ , such that among teachers who had relatively frequent use of manipulation and classification at pretest, LLC teachers were more likely to use manipulation and classification at posttest. Among teachers with relatively infrequent use of manipulation and classification at the pretest, neither group was likely to employ manipulation and classification at posttest, and posttest mean differences between LLC and PD-only teachers were small.

**Word-level fluency.** On the Time Spent in Recommended Practices Time Sampling Instrument, the number of time intervals where use of evidence-based word-level fluency strategies was observed was small at the beginning of the study and at the end of the study for both LLC and PD-only teachers, although both increased their use of these strategies over time. At pretest, the mean number of intervals in which teachers were observed using evidence-based word-level fluency strategies was 0.56 ( $SD = 1.21$ ) for the LLC group and 0.76 ( $SD = 1.50$ ) for the PD-only group. At posttest, the mean number of intervals in which teachers were observed using these strategies was 3.3 ( $SD = 3.36$ ) for the LLC group and 1.5 ( $SD = 4.04$ ) for PD-only group. An independent samples  $t$  test indicated that LLC teachers were not significantly different from PD-only teachers on number of intervals observed teaching effective word-level fluency strategies,  $t(39) = 1.57$ ,  $p = .06$ ; however, the effect of the LLC model was moderate ( $d = 0.49$ ).

**Fluency for reading connected text.** At pretest on the Time Spent in Recommended Practices Time Sampling Instrument, LLC and PD-only teachers were observed teaching evidence-based fluency strategies for reading connected text for a small number of intervals ( $M = 2.61$ ,  $SD = 5.94$ , and  $M = 3.02$ ,  $SD = 3.29$ , respectively). At posttreatment, LLC teachers had

more than doubled the mean number of intervals they were observed teaching these strategies ( $M = 6.57$ ,  $SD = 5.01$ ), and PD-only teachers decreased the number of intervals for fluency ( $M = 1.48$ ,  $SD = 3.66$ ). An independent samples  $t$  test of posttreatment means showed that LLC teachers were observed teaching evidence-based fluency strategies for reading connected text in a significantly greater number of intervals than PD-only teachers, and the effect of the LLC model was large,  $t(39) = 3.73$ ,  $p = .00$ ,  $d = 1.15$ .

### ***Knowledge for Teaching Word Study and Fluency***

On the Teacher Knowledge for Teaching Reading Survey, LLC teachers had a pretest mean of 30.05 ( $SD = 3.98$ ), and PD-only teachers had a mean of 26.25 ( $SD = 6.15$ ). The difference between the means was significant. At posttreatment, LLC teachers' scores increased by approximately 1.5 points ( $M = 31.50$ ,  $SD = 4.39$ ), and PD-only teachers' scores increased by approximately 3 points ( $M = 29.40$ ,  $SD = 4.45$ ). Analysis showed a nonsignificant Treatment  $\times$  Pretest interaction. Pretreatment scores were significantly correlated with posttreatment scores,  $t(39) = 4.86$ ,  $p = .00$ . The adjusted mean difference on posttreatment scores was nonsignificant,  $t(39) = 0.08$ ,  $p = .94$ , with a very small effect size,  $d = 0.02$ .

On the Knowledge for Teaching Reading Fluency Survey, LLC teachers began the study with slightly higher mean scores ( $M = 8.20$ ,  $SD = 1.62$ ) than those of PD-only teachers ( $M = 7.73$ ,  $SD = 2.34$ ), and the difference was significant. The Pretest  $\times$  Treatment interaction was nonsignificant. Pretreatment scores were significantly correlated with posttreatment scores,  $t(39) = 2.70$ ,  $p = .01$ . Both groups made gains in their knowledge from pre- to posttest. LLC teachers gained approximately 3 points ( $M = 11.32$ ,  $SD = 1.78$ ) and PD-only teachers, approximately 2 points ( $M = 10.03$ ,  $SD = 2.29$ ). The difference between groups on posttest-adjusted means was significant,  $t(39) = 1.86$ ,  $p = .04$ , and the treatment effect was small to moderate ( $d = 0.23$ ).

### ***Student Achievement Measures***

Overall, analyses indicated that students of teachers in the LLC model seemed to benefit more than students of PD-only teachers with regard to their word-level decoding skills (i.e., word study). The adjusted mean on the Woodcock Word Attack posttest was significantly higher for students of teachers in the LLC model (495.4) compared with students of PD-only (491.9) teachers,  $t(40.3) = 1.83$ ,  $p = .04$  (see Table 1 for unadjusted means and standard deviations and adjusted means). The LLC model had a moderate effect ( $d = 0.46$ ). The adjusted mean on DIBELS Nonsense Word Fluency—correct letter sounds was significantly higher for students of teachers in the LLC model (98.05) compared with students of PD-only (91.68) teachers,  $t(125.5) = 1.68$ ,  $p = .05$ . The effect of the LLC was moderate ( $d = 0.37$ ). The adjusted mean on DIBELS Nonsense Word Fluency—words read correctly was significantly higher for students of teachers in the LLC model versus students of PD-only teachers,  $t(42.6) = 1.73$ ,  $p = .05$ . Adjusted means were 29.0 and 26.0 for the LLC and PD-only teachers, respectively, and the effect of the LLC was moderate ( $d = 0.46$ ). There was no significant difference, however, on Woodcock Word Identification skills,  $t(36.2) = 1.07$ ,  $p = .07$ , for the two groups of students, and the Cohen's  $d$  was small ( $d = 0.12$ ).

There was no significant difference between the students of LLC teachers and the students of PD-only teachers on students' fluency with connected text as measured by DIBELS ORF,  $t(43.5) = 1.07$ ,  $p = .14$ , and the magnitude of the treatment effect was small ( $d = 0.17$ ). Adjusted posttest means were 89.07 and 86.05, respectively.

### ***Discussion***

The special education research literature frequently has highlighted the importance of high-quality reading instruction for students with LD, but few studies have examined effective PD to improve special education teachers' instructional practices to teach

**Table I.** Student Measures.

Measure	Pretest, M (SD)		Posttest, M (SD)		Posttest adjusted mean	
	LLC	PD only	LLC	PD only	LLC	PD only
WRMT-R						
Word Attack	486.88 (13.71)	483.67 (14.62)	496.80 (12.42)	489.85 (14.91)	495.37	491.88
Word Identification	457.31 (22.78)	451.92 (26.89)	472.39 (23.53)	464.56 (23.60)	469.17	467.22
DIBELS						
NWFCLS	83.25 (34.47)	81.22 (33.79)	99.69 (36.55)	89.52 (37.79)	98.05	91.68
NWFWRC	23.53 (12.39)	21.33 (13.44)	30.05 (13.95)	24.71 (14.09)	28.98	26.04
ORF	69.14 (29.45)	62.32 (27.80)	93.61 (36.31)	82.33 (30.36)	89.07	86.05
						.32

Note. ICC = intraclass correlation; LLC = Literacy Learning Cohorts; PD = professional development; WRMT-R = Woodcock Reading Mastery Test-Revised; DIBELS = Dynamic Indicators of Basic Early Literacy Skills; NWFCLS = Nonsense Word Fluency, correct letter-sound correspondences; NWFWRC = Nonsense Word Fluency, words read correctly; ORF = Oral Reading Fluency.

reading. Further, none have used a content-focused approach such as that advocated by Desimone (2009). Students with LD often have comprehensive learning needs in word study as well as in fluency, both at the word level and with connected text. Word study, especially structural analysis or multisyllabic decoding, is an area of significant need (e.g., Mellard et al., 2010; Wanzek & Haager, 2003). Without ongoing intervention that includes word study and fluency, many students with disabilities are likely to fall further and further behind (Torgesen et al., 2001; Vaughn, Gersten, & Chard, 2000). Unfortunately, special education teachers often lack the specific knowledge (Moats, 2009) and instructional skills (Brownell et al., 2009) necessary to implement high-quality reading instruction, indicating a need for effective PD that addresses this research-to-practice gap. In response to this need, our study examined the efficacy of a comprehensive PD model compared with a 2-day PD, both focused on teaching fluency and word study.

### **Teacher Outcomes**

Findings from this study, though underpowered in study design and somewhat mixed, support the promise of extended content-focused PD to improve teachers' instructional practice in word study and fluency, particularly for teachers who might need the most support. The quality of LLC teachers' word study instruction improved more than that of PD-only teachers, but the greatest effect was for teachers who began the study with the lowest-quality instruction. LLC teachers spent more time than PD-only teachers instructing students in evidence-based word study practices that involved teaching structural analysis or multisyllabic decoding skills. Further, there was an interaction effect such that teachers in the LLC model who spent less time than other teachers teaching evidence-based word study strategies involving manipulation and classification of sounds at pretest were more likely to benefit from the LLC model.

For fluency instruction, LLC teachers spent more time teaching evidence-based

word-level fluency and fluency with connected text strategies as compared with teachers in the PD-only group. LLC teachers also showed significant gains in the quality of their fluency with connected text instruction. Teachers in both groups devoted little time to word-level fluency instruction, likely because they had limited time to allot to activities such as sight word practice. Most teachers in our study had ≤30 min to devote to daily word study and fluency together.

*Content-focused PD was able to change special education teachers' word study practice and, in turn, influence their students' achievement in decoding and decoding efficiency.*

The LLC also had a mixed effect on teachers' knowledge; compared with PD only, there was a moderate and significant treatment effect on teachers' knowledge for teaching fluency. The effect on teachers' knowledge for teaching word study, however, was minimal and not significant. These findings should be interpreted with caution given the weak reliability of the instrument used to assess word study knowledge and the limited sample size.

### **Student Outcomes**

Many scholars and policy makers have asserted that PD models must demonstrate their efficacy by increasing achievement for students (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009; Desimone, 2009). In this study, we were able to demonstrate an effect of the LLC model on student outcomes, although the latter were distal indicators of the LLC's effect. The LLC model had a significant effect on students' word attack and decoding efficiency skills, and the effect was moderate to large. These student outcomes, combined with LLC model effects for teachers' word study practice, suggest that content-focused PD was able to change special education teachers' word study practice

and, in turn, influence their students' achievement in decoding and decoding efficiency.

The LLC model did not have the same effect on students' fluency outcomes. LLC teachers made significant gains on their knowledge for teaching fluency and the quantity and quality of their fluency instruction with connected text practice; however, these shifts in instruction did not significantly influence students' oral reading fluency outcomes. Previous studies have shown that increasing reading fluency scores of students with LD who are  $\geq 2$  years below grade level is quite difficult (e.g., Chard, Vaughn, & Tyler, 2002; Fuchs & Fuchs, 2004; Spencer & Manis, 2010). It is possible the students receiving instruction from LLC teachers, where there was an increased focus on decoding multisyllabic words, slowed down in their reading to use their newly developed decoding skills to read all the words in a passage, sacrificing reading fluency for accuracy and understanding a word's meaning. However, with the data available, it is difficult to determine if this was the case.

In addition, the LLC and PD-only teachers had limited time to devote to both word study and fluency instruction, and they described to us their struggle to balance the two types of instruction in that time. Even though teachers improved in their fluency with connected text instruction, they may not have had adequate time to leverage their instruction to improve students' oral reading fluency. In addition, students in this study, like other students with LD in schools, spent the majority of their instructional time in the general education classroom, and this introduces a source of variability that is difficult to address without much larger samples of teachers.

Given these complexities, it is encouraging that significant student effects for decoding were achieved in this study. Gains in word study are important because fluent and accurate word reading, particularly of multisyllabic words, enables students to access more sophisticated concepts in subject area texts (Archer, Gleason, & Vachon, 2003; Diliberto et al., 2009) whose use is emphasized in

college- and career-ready standards (e.g., Haager & Vaughn, 2013). The potential of extended content-focused PD for improving special education teachers' knowledge and practice and, in turn, their students' achievement certainly warrants further exploration.

We conclude that extended content-focused PD that includes support from coaching, video self-reflection, and monthly meetings shows promise for improving the knowledge and instructional practice of special education teachers and, accordingly, their students' achievement. Extended content-focused PD, however, may be difficult for school personnel to deliver given that special education teachers are often spread throughout a district. Future studies should examine the feasibility of extended PD for special education teachers and explore options in video coaching and technology to maximize efficiency and adaptability.

### ***Limitations***

The sample size was somewhat small for the use of hierarchical linear modeling analyses. Further, although the LLC treatment was effective as a package and more effective than a substantive 2-day PD effort, we were unable to measure the individual contributions of components of the PD model. For instance, we do not know if the collective participation structure (i.e., monthly cohort meetings) was more effective than the individual structure (i.e., observation and feedback from an expert coach) or if there was a group effect for the cohort on teacher and student outcomes. Future research can help clarify the influence of the individual components of the LLC treatment, perhaps by singling out specific components within treatment groups (Hill, Beisiegel, & Jacob, 2013), and larger samples can enable assessment of the statistical impact of the cohort. The need for a sufficient sample also required us to work in multiple school districts across three states that varied in terms of policy, curriculum, setting, and student populations. This variability contributed to the generalizability of the study's findings,

but it may have affected the study's internal validity. Additional research is needed to confirm our findings.

Measurement continues to be a limitation in studies of PD and teacher quality, as it was in this study. It requires tremendous effort to simultaneously develop and implement a PD package while developing and validating observation and knowledge tools that align specifically with the PD. Resources did not permit the creation of our own measures of teacher knowledge. Instead, we relied on previously constructed tests, a factor that likely affected our ability to adequately measure changes in knowledge for decoding multisyllabic words. Development of measures that focus on instructional quality is arguably the greatest area of need for further research.

Performing more than one teacher observation for the pre- and posttest would have increased power to detect treatment effects. Statistically significant treatment effects were demonstrated, however, on many of the teacher and student measures that assessed word study instruction and students' decoding skills, thereby supporting the validity of these observation scores. Future researchers should include several observations at a single point in time to assess measurement stability.

In addition, we did not adjust *p* values to account for multiple comparisons, which may have increased the likelihood of Type I errors. However, if we employed a Bonferroni correction, then it is likely we would have increased Type II errors. In our study, the *p* value to test for significance would have to have been .003 (.05/16). It is also important to note that of the 16 comparisons, eight were significant, which is much higher than what would occur by chance. Additionally, findings for teachers' instructional practice were relatively consistent in the area of word study and in students' decoding skills. Furthermore, effect sizes are somewhat moderate to large. Thus, it seems unlikely that positive findings are the result of Type I error.

Finally, any study of special education teachers encounters design and measurement challenges that have few solutions. Special education teachers in this study did not have

time to provide the sort of comprehensive reading intervention recommended in research on response to intervention (e.g., Vaughn et al., 2012); thus, they may have been unable to adequately demonstrate what they learned consistently enough to influence student achievement. In addition, general education teachers introduce an unknown source of variability—one that is difficult to measure and still maintain the cost-effectiveness of a study.

## Conclusions

Empirical studies focused on models of effective PD for special education teachers are scarce, and few have examined models that attempt to increase special education teachers' content knowledge and instructional practice for teaching reading (or other subjects), even though this is an area of primary need for the majority of students with high-incidence disabilities. In this study, teachers who received the full LLC model demonstrated significant changes in the amount of instructional time and quality of word study instruction, and these changes were associated with improved student outcomes. It seems that with extensive support, teachers are able to change their practice in a way that positively affects student achievement. Teachers in the LLC model increased their word study instruction during the study; teacher gains were accompanied by a moderate effect on students' word-reading gains. Likewise, the LLC model teachers significantly increased their time spent teaching validated passage fluency-building strategies—another essential component of reading that would readily translate to making access to classroom learning more feasible for students with LD across subject areas. Although there was no statistically significant effect on students' oral reading fluency in comparison with students in the PD-only group, it is promising that the LLC model teachers perceived fluency to be of sufficient importance to increase their instructional attention to it. In comparison with that of the PD-only teachers, the ongoing support that the LLC teachers received appears to have made an impact on their practice.

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