



Professional Development and Coaching in the Science of Reading: Impacts on Oral Reading Fluency in Comparison to National Norms

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The purpose of this 5-year longitudinal study was to examine the rate of growth of oral reading fluency (ORF) scores in response to professional development and coaching related to the Science of Reading (SoR) in one urban public school district in the northeast United States. A non-random sample of all grade 1-5 students (n=434) enrolled in the school over a five-year period was used. Analysis of the growth in ORF scores was conducted using a latent growth curve analysis within a structural equation model framework. This model allowed comparison of growth between the sample and established national norms. Results indicate that across the grades over time, the sample demonstrated significantly greater growth (9%) when compared to the national norms (6%), despite interrupted instruction due to the covid-19 pandemic. These results suggest that repeated Professional Development (PD) and ongoing coaching to implement the SoR can lead to long-term growth in student ORF. The implications support SoR as an effective instructional framework which may mitigate against loss of instructional time in the classroom and serve as a protective factor against school interruptions, especially for at-risk learners.

Keywords: science of reading, oral reading fluency, teacher professional development, teacher coaching

INTRODUCTION

While trends in reading assessment data are on the rise globally (Piasta et al., 2009; U.S. Department of Education: Institute of Education Sciences [IES], 2016), an exception to

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this finding is in the United States. As of 2019, only 35% of fourth-grade students in the United States were considered proficient in reading by National Center for Educational Statistics reading metrics (National Assessment Educational Progress [NAEP], 2019). Further, data shows that there is a persistent and pervasive achievement gap in reading development. This gap disproportionately impacts students who are classified as Black, Indigenous, and People of Color (BIPOC), and students from low socioeconomic backgrounds, and in urban contexts (U.S. Department of Education: IES, 2016). One explanation for this achievement gap is due to the lack of use of empirically rigorous reading practices (Binks-Cantrell et al., 2012; Castles et al., 2018; Kilpatrick, 2015; Seidenberg, 2017; Hanford, 2019). In response to this gap, researchers have begun to examine reading development and achievement through the lens of the Science of Reading (SoR), a body of rigorous, empirical research spanning 40 years across multiple disciplines that promotes evidence-based reading techniques (The Reading League [TRL], 2022; Solari et al., 2020). The preponderance of evidence across these research studies (Spear-Swerling & Sternberg, 2001) provides a research consensus demonstrating that there are highly effective practices for teaching reading which should be utilized to mitigate the achievement gap in literacy. Looking to literature reviews of seminal works (e.g., Adams, 1990; Anderson, Hiebert, Scott, & Wilkinson, 1985; Chall, 1983; National Council of Reading, 1998; Spear-Swerling & Sternberg, 1996; Stanovich, 1992), Spear-Swerling and Sternberg (2001) to identify seven such key areas:

1. Children who are learning to read an alphabetic language such as English appear to pass through a series of common developmental stages.
2. In the earliest stages of learning to read, children's sensitivity to the sounds in spoken words (i.e., phonological awareness) greatly facilitates their developing word-analysis skills; children who lack this awareness have trouble learning to read.
3. Accurate and fluent word analysis is essential to good reading comprehension, especially as children grow older and encounter increasingly difficult texts.
4. Most beginning readers benefit from explicit instruction in word analysis (i.e., phonics instruction), and for youngsters who are vulnerable to reading difficulties, this instruction appears to be particularly important.
5. To become skilled readers, children need much more than just word-analysis instruction—among other things, they need good comprehension instruction and extensive experience reading a variety of texts, such as books, magazines, and newspapers.
6. Instructional approaches that attempt to “match” initial reading instruction to certain characteristics of the reader, notably modality preference, are generally ineffective.
7. Children who experience serious difficulties in learning to read, including those classified as having reading disabilities or dyslexia, typically have difficulties in the areas of phonological processing and word analysis. (p. 53)

Additionally, more recent research reviews (e.g. Solari et al., 2020; Hall et al., 2022) have continued to align with these findings and indicated further precision around best practices for teaching reading. Despite this consensus, Solari et al. (2020), chide the research community on their lack of communication to educators regarding these research findings. Like-minded researchers have enacted a movement (The Reading League, 2022) to be more intentional in providing professional development around these findings to educators. Simultaneously, many teachers are recognizing a need to change their instructional approaches to better align with SoR; however, there is little research that investigates the effects of SoR-aligned professional development (PD) for teachers on student outcomes related to important components of reading. This study seeks to fill this gap by examining student reading outcomes when teachers are provided with comprehensive professional development in SoR.

Study Purpose

The purpose of this study is to examine the rate of growth of Oral Reading Fluency (ORF) scores in response to SoR PD and coaching in one urban public school district in the Northeastern United States. We hypothesize that the rate of ORF growth for students whose teachers are exposed to SoR PD would be significantly higher than that of national norms. The research questions for this study are:

- (1) What is the rate of student ORF growth over time following teacher PD in the SoR?
- (2) How does the rate of student ORF growth compare to the ORF rate of growth in national norms following teacher PD in the SoR?

Review of The Literature

Professional Development and Coaching

As teachers and schools attempt to improve student literacy outcomes through changes in instructional practice, the need for effective PD is imperative. There are specific well-established methods of PD that evidence suggests positively change teaching practice and improve student outcomes, including focused content, active learning, collaboration amongst teachers, clear modeling of effective practice, coaching and expert support, and sustained duration (Darling-Hammond et al., 2017). These researchers define coaching as, “the sharing of expertise about content and evidence-based practices, focused directly on teachers’ individual needs” (Darling-Hammond et al., 2017, para.7). Sanchez-Garcia (2023) emphasizes the importance of reflection as a “key transformative mechanism conducive to teacher growth” (p. 18). This reflection allows teachers to examine their own practices and challenge any misconceptions or inaccurate assumptions. Gersten, Chard, and Baker (2000) demonstrate that an “outside partnering force” and student success manifest continued use of the strategies by teachers. In addition, coaching, a PD practice defined as a more expert teacher in a specific topic striving to transfer knowledge and expertise to a teacher with less knowledge in a specific topic (Gürgür, 2017), has been found to significantly contribute to enhanced

teacher learning and student outcomes (Darling-Hammond et al., 2017; Gürgür, 2017; Onchwari & Keengwe, 2008).

According to Moats (2020), in the United States, PD for teachers that reflects the scientific research about how children learn to read is lacking. Misconceptions about how to teach reading abound and find their way into the PD that is most readily available. Further, there are no accountability measures in place to ensure that content provided during teacher PD is current and accurate. Due to these issues, research involving the effectiveness of PD in SoR is lacking. These issues negatively impact the knowledge and practice of teachers of reading and exacerbate the problems of reading achievement affecting U.S. students. According to Moats (2020):

“Every teacher who currently teaches reading would benefit from high quality education about reading development, language structure, and recent research findings. Validated instructional programs should be accessible to every teacher, along with consultation and demonstration of their effective use. Teachers need ongoing professional development that has topical continuity, practical application, and opportunities for collaboration with peers...These professional development experiences should be linked to continuous in-class coaching” (p. 25).

The Science of Reading

The SoR is a framework “representing the accumulated knowledge about reading, reading development, and best practices for reading instruction obtained by the use of the scientific method” (Petscher et al, 2020). The body of research around this framework is vast and emerges from decades of interdisciplinary scientifically-based research from multiple fields, numerous countries, and various languages (The Reading League [TRL], 2022; Solari et al., 2020). The culmination of this research provides a context through which a variety of educational stakeholders can make more empirically-sound decisions about how to most effectively teach literacy.

The studies making up the SoR have collectively identified five essential areas of reading instruction: (1) phonemic awareness; (2), phonics; (3), fluency; (4), vocabulary, and: (5) reading comprehension (National Institute of Child Health and Human Development, 2000 [NICHD], 2000; National Research Council [NRC], 1998; Rose, 2006). These elements are colloquially referred to as the “Big Five.” Research suggests that these elements should be taught using systematic, explicit, cumulative, and diagnostic pedagogy (Kilpatrick et al., 2019; Moats, 2019; NICHD, 2000). Specific instructional approaches in these five core areas provide benefit to students’ reading outcomes. For example, studies have shown the benefit of training in phonological awareness (Tibi & Kirby, 2018; Torgesen et al., 1999a; Vellutino et al., 2004; Kjeldsen, et al., 2014) with scaffolded use of manipulatives (Kilpatrick, 2015), explicit and systematic phonics instruction (Blachman et. al., 2014; Ehri, 2020; Martinez, 2011; Savage et al., 2018), extensive practice reading decodable text connected to newly learned phonics skills (Murray et al., 2014; Mesmer, 2010), instruction in oral language and vocabulary development (Beck et al., 2013; Konza, 2014; Language and Reading Research Consortium [LAARC] , 2015), and comprehension instruction that includes

the examination of genre, syntax, discourse, and intentional building of background knowledge (LAARC, 2015; Oakhill & Cain, 2012; Palincsar & Brown, 1984).

Research suggests that there are significant gaps in teacher knowledge surrounding how best to teach these essential areas of literacy (Binks-Cantrell, 2012; Cohen et al., 2017; Joshi & Wijekumar, 2019; Kilpatrick, 2015; Seidenberg, 2017). Although the research demonstrates a gap in teacher knowledge around the SoR, there is dearth of literature around how best to foster growth in SoR knowledge and pedagogical practices for teachers. Due to underperformance in student reading scores, school districts have begun to realize the need to explicitly teach these areas when working with children learning to read (Bazzaz, 2022; Fofaria, 2020) and address the gaps in teacher knowledge (TRL, 2022). The present study aims to fill the research gap around effective PD in SoR for teachers and its impact on student reading fluency outcomes.

Typical Reading Instruction in the United States

Despite research consensus around the five essential aspects of reading instruction, many American schools do not utilize instructional practices that are aligned with the SoR. According to a national study conducted by the Ed Week Research Center (2020), 72% of elementary special education and K-2 teachers reported that their schools use what is known as “balanced literacy” approaches. Many of the practices used in balanced literacy approaches emerge from the philosophy that reading develops naturally when students are surrounded with a literacy-rich environment (Lyon, 1998). The culmination of 40 years of SoR research demonstrates that this is not the case.

While many schools using this approach provide a nod to the “Big Five” as mentioned above, they often minimize the importance of how these elements are taught. Using explicit, systematic, cumulative, and diagnostic instruction across the five essential areas, is particularly important for students who have learning difficulties or who are otherwise at risk for reading problems (International Dyslexia Association [IDA], 2022). For example, in balanced approaches, reading comprehension might be facilitated through guided reading book talks, rather than through a teacher explicitly modeling metacognitive comprehension strategies using a gradual release model of instruction (Fisher & Frey, 2013; Archer & Hughes, 2011). In terms of word identification, as students read text, a teacher might point out how to sound out a word following the pattern of Vowel-Consonant-e. However, the instruction would generally be incidental and cursory as opposed to structured and systematic. This often leads to gaps in reading development. Since these instructional practices have not produced the desired reading proficiency outcomes, many states have enacted laws requiring teacher education in the SoR to correct this trend (Schwartz, 2021).

Reading Development

This study is informed by The Simple View of Reading (SVR) (Hoover & Gough, 1990; Hoover & Tunmer, 2018), a model of reading that posits that there are two main underlying constructs necessary for reading comprehension: decoding (D) and language comprehension (LC) as depicted by the equation $D \times LC = RC$. That is to say, to achieve reading comprehension, an individual must be able to identify the words in connected

text while simultaneously constructing meaning from those words. Although deemed “simple,” both constructs (decoding and language comprehension) are multifaceted in nature and require significant cognitive development (Scarborough, 2001).

Decoding Ability

Decoding ability encompasses knowledge of phonology and sound-symbol correspondences to decipher printed words leading to a large lexicon of automatically recognized words (Ehri, 2014; Raklin et al., 2014). For novice readers, most of the skills related to decoding ability are in development and cannot be drawn upon readily to support reading comprehension. Novice readers must devote considerable cognitive energy to the various facets of reading (LaBerge & Samuels, 1974). As reading instruction progresses, it is crucial that students develop automaticity with these skills in order to enact them with ease as they approach connected text. Research suggests that facility with decoding, in particular, at the early stages of reading is paramount because as students develop fluency, cognitive resources are “freed up” which can then be devoted to comprehension (Kim et al., 2011). Conversely, students who struggle in developing automaticity in decoding are constrained in their efforts to understand what they read (LaBerge & Samuels, 1974).

Language Comprehension

Language comprehension is a broad category that comprises skills such as vocabulary, background knowledge, structures of language, verbal reasoning, and literacy knowledge (Scarborough, 2001). According to the SVR, language comprehension is an essential aspect of reading comprehension as this is the area that allows readers to understand what it is that they decode. Readers need to know not only what words mean, but how they are used in various contexts, how word placement in a sentence affects meaning, and how a series of sentences connect to an overall conclusion. Moreover, world knowledge (Hirsch, 2003), domain knowledge, and literary knowledge support deeper understanding of texts including the ability to infer, a necessary skill as texts increase in complexity (Cain & Oakhill, 2011). The breadth and depth of language comprehension configurations are endless and in continual development. As stated by Catts & Hogan (2003), “a small vocabulary can limit the number of words available for recognition, while other language deficits can reduce the contextual knowledge a reader may use to identify a low frequency word (p. 231).” There is evidence to suggest that better-developed language skills, therefore, result in increased word recognition (Nation & Snowling, 2004) and fluency (Hirsch, 2003) as well as reading comprehension. Therefore, instruction in the subskills of language comprehension is imperative.

Oral Reading Fluency

Oral reading fluency is in many ways the application and behavioral outcome of the interaction of decoding ability and language comprehension. Oral reading fluency (ORF) is the ability to read a text aloud accurately, automatically, and with prosody (Aldhanhani & Abu-Ayyash, 2020; Padak & Rasinski, 2008; Samuels, 2007). Accuracy, in this context, is described as competency in phonic decoding (Rasinski et al., 2016). As accuracy increases, the amount of cognitive energy needed to complete the task is

significantly reduced helping to build automaticity. Further, disfluent reading can be reflective of weaker word recognition proficiency and faulty text processing (Rasinski et al., 2016). Automaticity in reading refers to the ability to recognize words instantly with little cognitive effort. Prosody, or reading with expression (using pitch, tone, pause, and phrasing) is the third necessary component of oral reading fluency (Rasinski et al., 2016; Schrauben, 2010). It has been posited that 90% of comprehension difficulties are a result of deficits in oral reading fluency (DiSalle & Rasinski, 2017). This illustrates the importance of ORF as a measure of reading success and as a gauge of overall reading proficiency (Hasbrouck & Tindal, 2017, Fuchs et al., 2001). Ultimately, the goal of reading is understanding a text, and students with weak reading fluency are less likely to persist and make sense of a text (Eppard, 2020; Stanovich, 2009).

Measures of ORF are standardized, individually administered tests of reading accuracy and rate (Hasbrouck & Tindal, 2017). To measure ORF, students are typically provided an unpracticed passage for which they have one minute to read orally as much as they can. As a student reads, an assessor takes note of incorrectly read words. The assessor then records a Words Correct Per Minute (WCPM) score. This procedure is repeated three times in one session and a median WCPM score of the three passages is used as the measure of oral reading fluency. According to Hasbrouck & Tindal (2017), the “WCPM score has 30 years of validation research conducted over three decades, indicating it is a robust indicator of overall reading development throughout the primary grades” (p. 1). In addition, oral reading fluency has been well-researched as a screening tool applying a standardized measure of reading accuracy and rate (Cummings et al., 2015; Hasbrouck & Tindal, 2017).

ORF National Norms

The ORF national norms were established by Hasbrouck and Tindal (2017), who obtained data sets of school and district norms from many different sites. The first established ORF norms date back to 1992 as scores from 45,000 students in grades 2 through 5 were compiled using curriculum-based procedures. This process was replicated in 2006 with an even larger data pool consisting of approximately 250,000 students and increasing the grade span from grades one through eight. It should be noted that the 2006 norm data largely came from commercially-available curriculum-based measurement tools, such as DIBELS and AIMSweb. In 2017, these norms were updated again, utilizing assessment-specific norms from DIBELS 6, DIBELS Next, and easyCBM (Tindal & Hasbrouck, 2017). The ORF national norms contain a breakdown of student scores at the 10th, 25th, 50th, 75th, and 90th percentiles for each grade level. Through use of the ORF normative data, student scores can be compared to determine whether students are at-risk for reading difficulties or progressing at comparable rates to same-grade peers (Hasbrouck & Tindal, 2017).

Tindal and Nese (2013) report that general education students typically demonstrate growth of one word per week in their oral reading fluency skills, while students in special education progress at a slower rate. While research suggests that ORF growth may not be linear and instead tapers as students progress in reading, weekly ORF growth was reported to consistently range from .50 to 2.0 correct words per minute (Tindal &

Nese, 2013). There is general consensus among researchers that 50th - 75th percentile performance is a “reasonable benchmark” for determining an appropriate reading rate (Hasbrouck & Glaser, 2011; Hasbrouck, 2020). Reading too slow or too fast can impede reading comprehension, which is the ultimate goal of reading, though fluency may vary depending on the task demands. Additional research indicates that reading fluency growth rates change over time by grade, showing a sharp increase in growth trajectory for students in grades 3-5, with a smaller increase as students advanced to grade 6 (Patarapichayatham et al., 2013). To date, there is limited research in the field examining longitudinal outcomes, such as ORF scores, as districts implement SoR after participating in PD.

Given that oral reading fluency can be used as a proxy for overall reading development coupled with the efficacy of SoR implementation, this study explores student ORF outcomes following teacher PD and coaching in the SoR. This study used a quasi-experimental design with participants compared to a norm-referenced group examining ORF scores across grade levels over time.

METHOD

Participants

Participants in this study were n=434 first through fifth grade students enrolled in a K-8 urban public school located in northeastern United States. School demographics are 53% White, 19% Asian or Native Hawaiian/other Pacific Islander, 14% African American, 8% Hispanic or Latino, 5% multi-racial, and 1% American Indian or Alaska Native. English Learners comprise 14% of the population, students with disabilities make up 22% of the population, and 67% of the students are considered economically disadvantaged (New York State Education Department [NYSED], 2021). This five-year longitudinal investigation used a non-random sample of all grade 1-5 students enrolled in the school at any point during that five-year period. Longitudinal tracking of the participants occurred through the use of identification numbers as the students matriculated through each grade. Attrition rates for the participants was less than 5% indicating the potential for little bias and loss of data across the years (Dumville et al., 2006).

Measures

This study examined Oral Reading Fluency (ORF) rates as a measure of student reading outcomes. Words Correct Per Minute is an indicator of ORF which is calculated by students individually reading and the assessor calculating the number of words accurately read within one minute on standardized grade-level passages. The data were collected by teachers each fall and spring as part of district standardized benchmark assessments during the course of normal classroom reading instruction from 2017 to 2021. During testing, teachers followed procedures outlined through AIMS Web. There were no data collected for Spring 2020 as a result of the COVID-19 pandemic and subsequent virtual instruction. Data for Spring 2020 were interpolated.

Using Oral Reading Fluency (ORF) scores is an accepted and well-researched metric for estimating student reading outcomes. This metric has been used over the past 15 years for universal screening in reading for elementary students (Hasbrouck & Tindal, 2017; 2006). ORF scores show strong psychometric properties, as it has been found to be highly correlated with statewide achievement test performance as shown in multiple studies according to meta-analytic research, confirming its validity ($r = .69$) (Yeo 2009; Barth et al., 2012) and has strong reliability (Barth et al., 2012; Reschly et al., 2009). The publishers of the ORF report a test–retest reliability coefficient that exceeded .85 (Shinn et al., 2002). ORF test-retest reliability within this current sample is illustrated at .87.

Procedures

PD began in 2016 and was ongoing throughout the five-year data collection period. The PD was focused on the SoR and was provided by Organization X (blinded) one of the fastest-growing organizations globally to spur the SoR shift in teacher practice. Organization X is a non-profit organization whose mission is to “advance the awareness, understanding, and use of evidence-aligned reading instruction” (Organization X website, n.d., para. 1). Organization X’s approach is to promote the knowledge base that exists on effective instructional techniques and to teach educators to reflect on their existing practices

The PD involved initial conversations with administrators, needs assessments, whole-staff education, and coaching related to teaching aligned with the SoR. While the procedures of PD hold fast to the SoR elements, they require reflection and consideration of the school context in which the intervention occurs. In this case, these procedures unfolded recursively as needs and learning gaps were made apparent to Organization X PD providers.

This PD was supplemented by Organization X coaching one day per week working with grades preK through 5. The reading coach supported teaching in the SoR through a host of multifaceted approaches including data analysis with administrators and data teams; classroom-based activities, such as planning with teachers, observing reading instruction, and modeling reading lessons; knowledge-building sessions including book studies; and providing resources/helping teachers adapt their reading instruction to virtual formats after the pandemic caused the closing of schools to in-person instruction. Embedded in the PD were opportunities for participants to discuss problems and solutions of practice with teachers, coaches, and administrators.

More intensive training was provided to the contracted coach and reading specialists who participated in LETRS (Language Essentials for Teachers of Reading and Spelling) training, which consisted of 12 days of high quality, in-person instruction and an additional 120 hours through online modules and assessments. LETRS “methodically addresses the systems of language underlying literacy, including phonology, orthography, semantics, syntax, discourse, and pragmatics” (Moats & Tolman, 2019, xvi). This content facilitated more effective reading interventions and strategic classroom support.

The stakeholders in the district entered the PD with varied knowledge and philosophical underpinnings that required sensitivity and empathy to the current status of knowledge, yet to bring change to the district as a whole, some of the beliefs and perspectives needed to be challenged with evidence of effective teaching practices based on the SoR. Specific changes around reading instruction consisted of the following:

- Restructuring of school data meetings to be focused on quantitative student data from progress monitoring (rather than anecdotal teacher perspectives on how the student was performing)
- Adoption of a SoR-aligned general education curriculum
- Modifications to instructional practices with teachers using more explicit, systematic, cumulative, and diagnostic approaches
- Teacher knowledge development of assessment and with an emphasis on interpretation of data
- Review and adoption of valid assessments of early literacy skills focusing on Oral Reading Fluency (ORF)
- Incorporation of benchmark and progress monitoring tools that specifically measured gaps in student achievement
- Analysis of benchmark and progress monitoring data with other collected measures of reading performance, utilizing a combination of assessments to identify targeted needs and drive small-group intensive instruction
- Archiving district data to allow for analysis of effectiveness of instructional changes and making the data available to all staff

Classroom instruction made use of the precepts of the SoR. Treatment fidelity for implementing the SoR was established through examination of coaching logs and interviews conducted with the literacy coaching director for the school. Coaching logs were completed on a weekly basis, providing notes from teacher observations, individual teacher meetings, and data team meetings. The interview with the literacy coaching director for the school was conducted following the fifth year of the study, and consisted of a virtual interview spanning a two-hour period focused on PD implementation and role of the district coach. By the fifth year of the study, it was estimated that 90% of teachers were implementing pedagogy in alignment with the SoR.

Analysis

This study used an observational design that examined ORF scores over time with comparison to national norms. Analysis of the growth of ORF scores was conducted using a structural equation model framework. This framework has multiple advantages, including reducing sources of measurement error, approximating indirect effects, and illustrating growth (Christ et al., 2014). Initially we undertook a multilevel two-group (national norms versus study sample) longitudinal confirmatory factor analysis to allow a deeper understanding of the constructs of interest across grades over time. The latent growth curve analysis examines differences in the growth of the Oral Reading Fluency construct between national norms growth and sample growth. All analyses were conducted using the Mplus 8.6 statistical package [maximum likelihood method] (Muthen & Muthen, 2017). Multiple models were tested for goodness of fit. Fit indices

used to evaluate models include chi-square, Root Mean Square Error of Approximation (RMSEA) (< .08), Comparative Fit Index (CFI) (>.95), Standardized Root Mean Residual SRMR (<.08), and the model with the lowest Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC). A value less than 0.08 is considered a good fit (Hu & Bentler, 1998; 1999). It should be noted that chi-square is highly sensitive to sample size (Mostafa, 2020). Model fit values are displayed in Table 1.

Table 1
Model Fit values

Model Type	χ^2	RMSEA		SRMR	BIC	AIC
	Value	Value	95% CI			
Configural Invariance	759.14	.058	.051-.065	.064	3706	3688
Metric Invariance - Across Grade	848.47	.061	.057-.065	.067	4782	4844
Scalar Invariance Across Grade	877.33	.066	.060-.072	.071	9741	9641
Homogeneity of Variance / Covariance	1489.35	.060	.055-.065	.076	3778	3914
Homogeneity of Variance	877.21	.068	.061-.075	.074	3899	3812

Note. Homogeneity of variance and covariance of the latent constructs was tested for subgroups within the sample (e.g., race, special education status, etc.). Non-significant omnibus tests indicate that the interrelation of the constructs across groups does not differ. Post-hoc testing of homogeneity of the variances and covariances indicated that there were not enough differences between the groups to use a multiple-group latent growth curve analysis (LGCA).

FINDINGS

Rate of Oral Reading Fluency Growth Over Time

We conducted a comparison between national norm growth and the sample year-over-year growth in relationship to ORF scores. The data points from 2017-2018 were set equal to zero or no significant difference between the national norm growth and our sample growth (see Figure 1). Setting the difference between national norms and sample data to zero penalizes our sample, ensuring that growth rates are not overestimated as previous literacy measures [different than those used in this study] indicated that prior to treatment, the sample group was below national norms.

Results indicate that across the grades over time there is a continuous upward trend in ORF scores for both the SoR group and national norms; however, our sample illustrates significantly greater growth than the national norms. The rate of growth over time was 9% on average for the SoR group in comparison to an average national norm group growth of 6%. It is likely that in a setting with uninterrupted instruction, the SoR group growth rate would have been even greater, but regression of growth was noted due to the COVID-19 pandemic (Year 3). It should be noted that the national norms do not reflect learning interruption due to COVID-19, whereas the study sample does reflect interrupted learning in 2019-2020 and 2020-2021. Additionally, because it is likely that the SoR group started below national norms, this would indicate even greater growth for the sample group. We attribute this expedited growth rate in ORF scores to the SoR

intervention and its impact on reading achievement. Figure 1 illustrates growth in ORF in the SoR sample and national norm group.

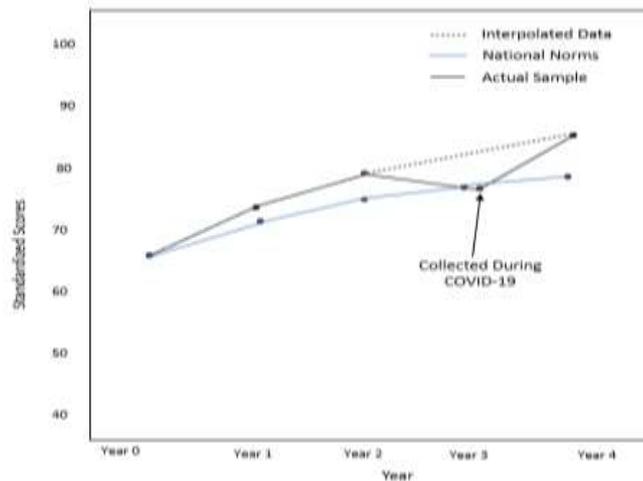


Figure 1
Growth in ORF in comparison to national norms

Evaluation of Confirmatory Factor Analysis

Multi-group confirmatory factor analysis (CFA) was conducted to assess the extent to which the latent reading constructs associated with ORF were comparable across each grade over time. The ORF construct was examined as a behavioral outcome of the latent constructs influenced by the SoR. Within the CFA, the construct (ORF) was assessed at each grade level across time.

The initial configural invariance model of ORF growth was associated with each of the indicators across grades and time. The data was centered on a mean of 0 with a standard deviation of 1. Variance for each of the indicators was fixed to 1.0 and intercorrelations across all constructs were allowed to freely vary. The configural invariant model fit the data as shown in Table 1, indicating that the pattern of loadings for each latent construct was similar across grades. Measurement invariance was evaluated by equating loading and intercepts in a stepwise manner. Steps were as follows: (1) evaluate factor loading across grade levels; (2) examine construct equality across grade levels. Each of the models had acceptable statistical fit indicating invariance across grade levels (e.g., the same construct is measured across each grade). The study team specifically used the measure of ORF scores as an estimate of the levels and shapes of the LGCA models in this study.

Evaluation of Structural Equation Model

The study team specifically used a multilevel two-group and shape model using the slopes of the ORF scores fixed at 0 for before the intervention and 1 for post-intervention and changing across grades (Little et al., 2006). In this model, weights for

years 2017-2021 were unrestricted to allow free estimation of growth in ORF over time. Within this type of model, the level or intercept is interpreted as the initial reading status in Year 1. The shape factor represents the optimal change in reading ability trajectory, uncovering nonlinearity in growth. Figure 2 is a structural equation model that includes constructs of ORF.

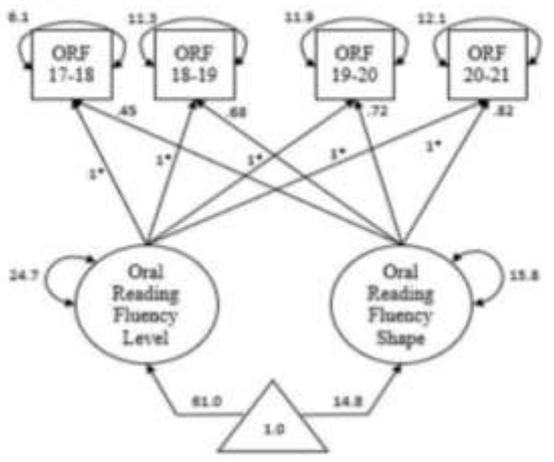


Figure 2
Longitudinal structural equation model displaying change of ORF scores over time

The initial model, allowing free estimation of the unique loadings for each shape factor across grade over time, showed good model fit ($\chi^2(3894)=234.62, p=.002$; RMSEA=.069, CI RMSEA=.065-.073, SRMR=.061, CFI=.96, and TLI=.83) at a significance of .05. A statistically significant chi-square is not of concern because of the sensitivity of chi-square to sample size. Inspection of the loading shown in Figure 2 indicated a slight curvilinear pattern of growth, with maximal growth occurring between Year 1 and Year 2. This pattern held true for the construct of ORF within the SoR sample. In addition, despite the initial dip in scores due to the Covid-19 pandemic and interrupted instruction in the spring of 2020, growth scores rebounded over the next year. Of note, national reading scores have declined since the pandemic (NAEP, 2022). Further, the pandemic has had negative psychological and academic effects on children (Busaad & Alnaim, 2021).

DISCUSSION

This study attempts to fill the gaps in the literature by examining longitudinal student reading outcomes (ORF scores), as districts shift their instructional practices toward the implementation of SoR following PD and coaching. Within this current study we examine the rate of growth of ORF scores across grades one through five in response to SoR PD and coaching.

We hypothesized that the rate of ORF growth for students whose teachers are exposed to SoR PD would be significantly different than that of national norms. Our results support

this hypothesis. To evaluate the rate of ORF growth over time for students exposed to SoR, a Latent Growth Curve Model (LGCM) within a SEM framework was developed. Evaluation of the effects of time and number of years of exposure to SoR PD occurred through the nesting of ORF scores by year. By nesting the ORF scores within the years, the authors captured the variation due to time of exposure. Use of the LGCM allowed the authors to specifically examine the effects of time of exposure on the implementation of SoR at the student level. Residual values seen within the LGCM indicate that a significant proportion of the variance in reading scores is tied to SoR coaching and implementation in the classroom. Results demonstrate that, when compared to the national norms, the sample group growth rates were on average three percent higher on ORF. The SoR intervention and practices account for a significant proportion of the growth seen in ORF scores. Model coefficients associated with ORF examined across each of the years are .45, .68, .72, .82, respectively, demonstrating a continual positive change resulting from the use of the SoR techniques by teachers. Examination of the shape of the LGCM is curvilinear, as expected, in that the inputs for learning e.g., the SoR, do not have a one-to-one relationship with the outputs (Cassady & Finch, 2020), and that is confirmed with this model.

While growth was observed over the course of the full study, one exception occurred in 2019-2020, when there was a regression in the ORF scores. This lack of growth was attributed to the disruption in the school year during the Covid-19 pandemic. Many of the children were moved from face-to-face to online classes resulting in disruptions to attendance and learning, as well as the reduction of SoR implementation. Additionally, this year only included data from the fall which is often lower than Spring ORF due to “summer slide” (i.e, regression of reading outcomes over summer months due to interrupted instruction) (Hasbrouck & Tindal, 2006). Due to this, the authors interpolated the data to approximate growth as if there were no disruption using a linear best fit approach between points (Riveros, 2020). Results of the interpolation illustrated a continuous upward trend in growth related to ORF across grades that would have exceeded the national norm model. This finding is speculative and based upon previous growth trends in the data.

ORF has long been considered an indicator of overall reading proficiency (Hasbrouck & Tindal, 2017, Fuchs et al., 2001) with the premise that one must read with efficiency to make meaning from what they are reading (Eppard, 2020; Stanovich, 2009). According to Bigozzi et al. (2017), the impact of ORF extends beyond just reading classes and impacts literacy-based subjects, such as English, History, Geography, Mathematics, and Science. The impact of improving ORF holds long reaching effects into overall school outcomes (Bigozzi et al., 2017).

We attribute the expedited ORF growth observed in this study to the perpetual, intentional, and recursive SoR PD and the subsequent shifting of teaching practices to those in alignment with the SoR. During the PD, teachers learned about key elements of empirical research and how to draw conclusions that fostered a growth in teacher knowledge around how to critically examine curriculum, evaluate common teaching practices, and learn pedagogy that is in concert with the SoR. This critical examination

of pedagogy resulting in teacher change is in alignment with findings from Sanchez-Garcia (2023), which emphasized the importance of reflection and challenging previously held beliefs. The PD provided consistent and repeated support (over five years) throughout the study, helping to ensure fidelity of implementation and capturing of SoR principles in the classroom. Research is clear that for teacher change to occur, PD should be interconnected, non-linear, and driven by teacher need (Clarke & Hollingsworth, 2002) with support through coaching and ongoing, recursive guidance (Joyce & Showers, 2002; Darling-Hammond et al., 2021). Further, cursory attempts at professional development do not have long lasting effects (Clarke & Hollingsworth, 2002).

The PD fostered shifts in practices that incorporate the SoR to more fully integrate evidence based pedagogy, helping teachers attend to diagnostic data and tailor instruction to students' individual needs. The escalated growth rate observed in this study corroborates SoR literature demonstrating that growth in reading ability increases with instruction that is explicit, systematic, cumulative, and diagnostic (Kilpatrick et al., 2019; Moats, 2019) in the five major components of reading: phonological awareness, phonics, fluency, vocabulary, and comprehension (NICHD, 2000). The gains observed in this study are noteworthy given the demographics of the school which indicate several high risk factors that typically contribute to lack of reading growth (poverty, English Language Learners, students with disabilities, etc.) (NRC, 1998).

It is important to note that this study was inclusive of students with disabilities and English Learners. Studies show that students without disabilities and those who are English-speaking tend to outperform students with disabilities and English Learners, both with regards to initial performance and academic growth (Gilmour, 2019; Wanzek, et al., 2013). The demonstrated growth above national norms with the inclusion of students with IEPs (22% of the sample) and English Learners (14%) for the SoR sample is an important finding. Further, the sample contained students with more severe disabilities, including autism spectrum disorder, other health impairments, and students with specific learning disabilities in reading. While the national norms (2017) were compiled through extant data of students receiving Tier 1 core classroom instruction, it is assumed that the national norm sample included students with mild and moderate disabilities (J. Hasbrouck, personal communication, May 2, 2022), but not severe disabilities. Additionally, other studies have excluded participants with more significant forms of disability in their analysis of reading growth (Copeland & Keefe, 2007; Duffy, 2016). The results of this study, therefore, illustrate the utility of SoR based instruction for groups which often are resistant to other forms of reading intervention and who are often not included in the data sets. The inclusion of students with differences allows for a greater understanding of the broader applicability of pedagogy rooted in SoR techniques in not just general education but special and language acquisition education as well.

In addition, there is sometimes a propensity for educators to dismiss initial pedagogical changes (Sanchez-Garcia, 2023) due to deeply held beliefs. In addition, the rapidly changing nature of educational pendulum swings that have occurred over the years

(Castles et al., 2018), causes confusion and skepticism regarding best practices in literacy instruction. It is essential for educators to understand that the SoR is based on 40 years of rigorous, empirical research studies and is not a pendulum swing, but rather a consensus of research findings (TRL, 2022). These findings will help to build a greater understanding of how reading improves. Therefore, it is imperative that schools are consistent and intentional in their approaches to PD, “staying the course” to deepen teachers’ understanding of and ability to implement the SoR. Essentially schools must ensure teachers possess strong knowledge of the structure of language and pedagogical practices and fully adopt implementation of the SoR rather than shifting to the “next new thing” before implementation fidelity truly develops within a school setting. Fidelity of practice is crucially important (McKenna et al. 2014). In this study, reading coaches were present regularly to work with teachers to ensure fidelity of implementation. Based upon this study we estimate SoR adoption and implementation takes at least three full years. The results of this study suggest evidence for SoR as an effective instructional framework which may mitigate against loss of instructional time in the classroom and serve as a protective factor against school interruptions.

IMPLICATIONS

The results suggest that the approach used in this study is beneficial for schoolwide curricular changes. Repeated PD and ongoing coaching to implement the SoR can lead to long-term gains that can have direct impacts on student outcomes. This type of intentional, recursive professional development is crucial to enact the changes seen in this study.

It is important to recognize that the PD was provided over a five-year period and calls into question the “one and done” type of PD often observed in schools. We recommend the following over a multi-year period:

- Establish a need for change of literacy practices based on assessment data and inconsistency with the schoolwide literacy practices.
- Recruit administrators. Gauge and foster investment.
- Invest in ongoing, recursive PD for teachers and administrators in SoR. This instruction should be provided by experts who are knowledgeable in the structure of language, body of SoR research, and pedagogy that is explicit, systematic, cumulative and diagnostic (structured literacy).
- Procure coaching that provides planning support, modeling of lessons and instructional techniques, implementation of diagnostic assessments, analysis/interpretation of data, etc.
- Implement changes to assessment practices, pedagogy, curriculum, instructional materials, and school schedules to prioritize SoR practices conducted with fidelity
- Reflect on implementation attempts and student outcomes with coaches and make changes as needed.
- Revisit, refine, and continue learning through PD and coaching in SoR.

LIMITATIONS

This study was impacted by the COVID-19 pandemic. Instruction, PD, and data collection were interrupted as a result of school shutdowns and quarantines. Due to a shift to virtual instruction in the Spring of 2020, data were interpolated rather than directly collected for the Spring benchmark of that year only. Despite these interruptions, growth was still demonstrated. Therefore, it is possible that growth would have been even more robust with a consistent instructional schedule.

Future research should investigate the longitudinal effects of SoR professional development and instruction implementation on other areas of literacy such as phonological awareness, decoding, comprehension, and text composition. Additionally, research should continue to examine the protective effects of SoR for vulnerable students, such as students with special needs, lower socio-economic backgrounds, non-dominant cultures, and English learners. Further studies should address the effects of Covid-19 and subsequent school closures/shift to virtual instruction impacting ORF scores when the SoR is and is not implemented.

CONCLUSION

Conclusions of the present study demonstrate that as teachers gained knowledge of the SoR, they were able to apply it in the classroom effectively. SoR PD shifted teacher instructional practices providing students with higher quality instructional experiences, which in turn positively impacted the students' rates of growth in ORF, exceeding national norm growth despite pandemic interruptions and inclusion of at-risk learners. Over time, the teachers changed to adopt new curriculum and learning materials, instructional routines that facilitated mastery learning, and more systematic, explicit, cumulative, and diagnostic instruction. This was possible due to on-going teacher PD, coaching, lesson models, and implementation discussions. Results speak to the benefit of SoR-aligned instruction in supporting reading growth, especially for at-risk students. Implications suggest implementing strong SoR PD and coaching and subsequent curricular changes may lead to greater reading growth than national norms and may serve as a protective factor against school interruptions, especially for at-risk learners.

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APPENDIX

Mplus Syntax for Latent Growth Curve Modeling

TITLE: ORF;

DATA: ORF.dat;

VARIABLE: NAMES ARE orf time1-time5;

USEVAR ARE orf time1-time5;

ANALYSIS: TYPE = RANDOM

MODEL ip sp | orf AT time1-time5;

ip sp | ON orf

Orf (res_p);