Learning to Read: A Review of Research on Growth in Reading Skills

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Abstract

Much of the research on curriculum-based measurement (CBM) in reading has focused on oral reading fluency (ORF). However, ORF is but one of five critical skill areas in the wider construct of reading (phonological awareness, phonics, fluency, vocabulary, and comprehension) and presumes early literacy as foundational skills. In this paper, we address the construct of readiness in learning to read (entering Kindergarten) and then redirect the findings to the results from learning to read over the school year (in both Kindergarten and Grade 1) by first describing group distributions and then presenting results from a two-level hierarchical linear model modeling growth with student characteristics.

Learning to Read: A Review of Research on Growth in Reading Skills

Since the original study by the Institute for Research on Learning Disabilities (IRLD) over three decades ago (Deno, Mirkin, Chiang, & Lowry, 1980), oral reading fluency (ORF) has garnered much of the attention of researchers interested in empirically investigating reading development and growth through the use of curriculum-based measurement (Fuchs, Fuchs, & Compton, 2004; Wayman, Wallace, Wiley, Tich'a, & Espin, 2007). Originally focused on technical adequacy of measures and the development of alternate forms to establish time series data largely for the purposes of instructional and programmatic evaluation, researchers have made great advancements studying ORF in the post-IRLD world. Using advanced analytical techniques (e.g., hierarchical linear modeling) that allow for modeling of complex and multilevel phenomena over time, researchers have targeted growth in ORF, uncovering patterns such as disparate seasonal student growth trends (Ardoin & Christ, 2008; Graney, Missall, Martínez, & Bergstrom, 2009), non-linear (decelerating) growth (Christ, Silberglitt, Yeo, & Cormier, 2010; Nese et al., 2012; Speece, Ritchey, Cooper, Roth, & Schatschneider, 2004), and lower initial status and growth rates for students receiving special education services relative to general education populations (Christ et al., 2010; Deno, Fuchs, Marston, & Shin, 2001). While these findings have profound impact on the validity with which educators and policy makers can interpret student achievement results and establish short- and long-range growth targets, the perhaps justified, but laser-like focus on ORF has left research around other important early literacy skills relatively disregarded until more recently when early literacy growth trajectories have been made observable (Tindal, 2013).

The Importance of Early Literacy Measurement

Oral reading fluency is but one of the big five areas of reading identified in the seminal Report of the Commission on Reading, in which the federal government made a nationwide call to emphasize reading in our nation's schools (R. C. Anderson, Hiebert, Scott, & Wilkinson, 1985). Three events appear to have prompted research around early literacy achievement and growth (Tindal, 2013). First, the National Reading Panel outlined essential components of effective reading instruction and learning, emphasizing: phonic awareness, phonics, fluency, vocabulary and comprehension (National Institutes of Child Health and Human Development, 2000). Second, the rise of accountability testing also helped to spur such measurement of early reading. *The No Child Left Behind Act* (NCLB) required educators, schools, districts and state to have students proficiently reading by the end of Grade 3 (Committee on Education and Labor, 2001). Early literacy skill development thus became inherently critical if all students were to make such progress in reading. Third, closely following and mandated under NCLB, the federally funded *Reading First* initiative further focused attention on nationwide early literacy improvement. Following these events, Fuchs et al. (2004) aptly noted, "additional research is needed to examine the tenability of reading tasks that address an earlier phase of reading" (p. 7), and researchers, to an extent, have heeded their call, though further investigation is warranted.

Early Literacy Skill Relations

Researchers from across the country, and indeed the world, have found key early literacy skills to be important predictors of later reading development. Notably, skill in sounding out letters and phoneme segments in Kindergarten predicts nonsense word fluency, word reading and reading comprehension at the end of the same grade (Linklater, O'Connor, & Palardy, 2009). Examining the distal effects of these early sublexical measures, Kindergarten letter naming and

letter sounding measures were significant predictors of end-of-year Grade 1 ORF, even beyond that of the first measure of ORF in Grade 1 (Stage, Sheppard, Davidson, & Browning, 2001).

In an intricate and complex study, Speece, Ritchey, Cooper, Roth and Schatschneider (2004) analyzed reading growth longitudinally from Kindergarten to third grade for 40 students. In their growth curve analysis, they incorporated several variables theoretically relevant to the transition from emergent to conventional reading (Whitehurst & Lonigan, 1998) to predict year-end third grade reading performance and the rate of growth for three measures of later reading skills: letter word identification, word attack and passage comprehension. Kindergarten measures of general oral language, phonological awareness, emergent reading (TERA-2), spelling, and background factors (i.e., family literacy and nonverbal IQ) were examined as predictors of intercept and growth in the study. Their findings substantiate and extend claims from both earlier and later studies of early literacy skills. Perhaps the most significant finding was that Kindergarten phonological awareness was a unique predictor of third grade word-level knowledge-skills, letter word identification, and word attack. "It appears that the unique linguistic roots of word-level reading at third grade are limited to the influence of phonological awareness skill" (p. 328). From a predictive validity view, later word reading performance has been firmly established for most students in their ability to phonologically process letters and sounds.

The only unique predictor of growth in the study involved the letter word identification outcome, which was predicted by emergent reading as measured by the TERA-2 (Speece et al., 2004). It is noteworthy that the TERA-2 is comprised of knowledge of the alphabet and its functions, construction of meaning, and conventions of written language. Therefore, the TERA-2 uses both alphabetic (graphemic) as well as more sophisticated processing skills to define what

it means to be an emergent reader. Thus, the findings of Speece et al. (2004) underscore the interrelated nature of sublexical reading components in predicting later (and higher order) reading skills.

In a follow up study, Ritchey and Speece (2006) highlighted the complex and interrelated nature of early graphemic and phonic reading fluency components and their critical importance to later reading development. They reported that letter sound fluency acts as a bridge between other sublexical features (i.e., letter names and phoneme segmenting) and higher order reading skills in that it more strongly predicted word reading and spelling compared to accuracy-based counterparts. "Fluent recognition of letter-sound associations may provide the mechanism that supports phonological recoding, blending, and accurate word identification" (Ritchey & Speece, 2006, p. 321). Ritchey (2008) followed up her work with Speece, confirming the importance of letter sound fluency as an early literacy skill critical to later word and passage reading fluency.

Situating the Current Studies

Given the importance of these early literacy skills, states are responding by formally measuring early literacy, in some cases from the time that students enter the public school system. In this particular state, all school districts must "administer the Oregon Kindergarten Assessment to students enrolled in kindergarten beginning with the 2013-2014 school year" (Oregon Department of Education, 2013). This requirement was designed to address four issues about (a) children arriving at kindergarten ready to learn, (b) changes in their level of school readiness over time, (c) disparities among children in various demographic groups (geographical, cultural, racial, and socioeconomic), and (d) particular skill areas to target. As this executive numbered memo notes: The assessment is designed to provide parents and teachers with a common understanding of what children know and are able to do upon entering kindergarten. "This type

of information can help teachers target instruction to meet students' individual learning needs" (Oregon Department of Education, 2013)

With the emphasis on early literacy from both empirical research and legislative intention, we focused our study on dimensions that need better explication as students learn to read. The first critical issue is to investigate the construct of 'readiness' for students entering the school system. Second, readiness to read needs to be contrasted with learning to read (as documented by change over time) in the normal course of development. Finally, this group effect needs to more carefully document a cohort of students on their within year-growth in which student characteristics are entered into the hierarchical linear growth model.

Methods

We organize our methods by sample, measures used in the study, and analyses conducted at the Kindergarten and Grade 1 levels. Note two important distinctions need highlighted in the sample: Whereas the sample of students in the first study are from one state participating in a pilot study on readiness, the sample from the second study represents a national sample. Students from both groups, however, took the same academic measures with the national sample also having winter and spring measures in contrast to the fall only measures with the first sample.

Samples

In the first sample, 1,228 students from 16 districts, 33 buildings, and 31 teachers participated in the pilot study. Of this group, 578 students were female (representing approximately 47%) and 649 were male (53%), with one missing value.

In the second study on change over the year in early literacy skill development, data were collected from an extant database. Existing data from the 2011-2012 academic year were extracted from the easyCBM district-member database, which included approximately 4,500

students nationwide. In neither study were data were collected with any sort of experimental design. Rather, the data reflect a convenience sample of students.

Measures

In the first study, we used a rating scale with 17 items that teachers completed on each student. Using a four-point scale they rated students on the frequency with which various classroom behaviors were present (from 1 = never to 5 = very frequent). We did not use this rating scale in the second study.

In both studies, we used easyCBM early literacy interim-formative assessment measures. easyCBMs were developed from the earlier empirical research on early literacy assessment (National Institutes of Child Health and Human Development, 2000) which had been shown to be important predictors of later reading skills and growth (V. L. Anderson & Tinker, 1936; LaBerge & Samuels, 1974; National Institute for Literacy, 2008; Ritchey, 2008; Ritchey & Speece, 2006; Speece et al., 2004). The skill measures in this study included: two measures of alphabetic literacy, *Letter Names* and *Letter Sounds*; one measure of phonological awareness, *Phoneme Segments*; and *Word Reading Fluency*. Kindergarten students took the following measures (a) Letter Names, (b) Letter Sounds, and (c) Phoneme Segments. Students in Grade 1 took three measures: (a) Letter Sounds, (b) Phoneme Segments, and (c) Word Reading Fluency.

Letter names. The measure tests students' skill in naming the letters of the English alphabet aloud (Alonzo & Tindal, 2007a). Individually-administered, students are shown both lower case and capitalized letters organized in a single one-page form and name as many of them as they can over a set amount of time (30 to 60 seconds based on the test version). Student self-corrections are counted as correct responses with the number of correctly named letters counting as the student's raw score. Assessors commonly calculate a 'per minute' fluency-based score

when the 30-second test version is used. Letter Names is available to district easyCBM users as a Kindergarten fall benchmark, and as 17 alternate, equivalent progress monitoring forms. Results from the Kindergarten fall benchmark are included here.

Letter sounds. This measure is an early literacy test of students' skill in orally sounding out letters of the English alphabet (Alonzo & Tindal, 2007a). In this individually administered measure, students are shown a series of lower case and capitalized letters, naming as many of them as they can over 30 or 60 seconds, depending on the test version administered. As is the case with the Letter Names test, students' raw scores are calculated based on the number of letter sounds correctly identified in the time allotted, with self-corrections counting as correct responses. Assessors will typically convert raw scores to a 'per minute' fluency-based score as necessary. Letter Sounds is available to district easyCBM users as Kindergarten and Grade 1 fall, winter and spring benchmarks, with 17 alternate equivalent progress monitoring forms also available at both of these grade levels. Results from all three benchmark assessments for Kindergarten and Grade 1 are included in this study.

Phoneme segments. The test measures students' skill in identifying phonemes within individual words. Assessors administer a test form to an individual student saying each word aloud to the student. Upon segmenting a word, the assessor delivers the next word verbally to the student, repeating this sequence for typically 60 seconds. Over the allotted time, students verbally segment as many words into phonemes as they can. Students' raw scores are calculated based on the number of phonemes correctly identified, with self-corrections counting as correct responses. Again, when tests are administered for less than a minute, assessors commonly convert raw scores to a 'per minute' fluency-based score. The Phoneme Segmenting test is available to district easyCBM users as Kindergarten fall, winter and spring benchmarks, and as a

fall benchmark assessment for Grade 1. Additionally, 17 alternate equivalent progress-monitoring forms are available at both grade levels.

Word reading fluency. This measure tests students' skill in correctly reading both sight-words and words that follow regular patterns of letter and sound correspondence out loud (Alonzo & Tindal, 2007b). Students are shown a test form with various decodable and sight-words arranged in a one-page chart, and are prompted to read the words from left to right and then down successive rows. Typically for 30 or 60 seconds, students verbally read as many words as they can. Students' raw scores are calculated based on the number of words correctly read, with self-corrections counting as correct responses. The student receives one point for every correct response with assessors commonly converting raw scores to 'per minute' fluency-based scores for interpretation. Available as benchmark and progress monitoring forms for grades K-3, results from the Word Reading fall, winter and spring benchmark assessments for Grade 1 are considered in this study.

Psychometric Properties of the Early Literacy Measures

Alonzo and Tindal (2009) documented alternate form and test-retest reliability for the following measures in Grade 1: Phoneme Segmenting, Letter Sounds, Letter Names, Word Reading Fluency, and Passage Reading Fluency. All coefficients were quite high (no lower than .75 and often well above .90). Anderson, Park, Lai, Alonzo and Tindal (2012) confirmed these results with Grade 1 measures (Letter Sound and Names) for both test-retest and alternate form reliability. In addition, using generalizability theory (G-theory) they reported that most of the variance was with persons and not forms or occasions. Additionally, criterion validity (both concurrent and predictive) was established with the SAT (10^{th} edition) for the early literacy measures in Kindergarten and grade 1. Finally, construct validity was established with a (SEM)

model used to explain literacy skill development from social and task oriented behaviors.

The Phoneme Segment measure has been aligned with Common Core State Standards (CCSS; foundational skills) in grades Kindergarten and 1 (Sáez, Irvin, Alonzo, & Tindal, 2012). Although these skills were only weakly aligned in Kindergarten, they were strongly aligned in Grade 1 with Standard Two expectations. Similarly, the K-1 Word Reading Measures have also been aligned to the CCSS foundational skills (Sáez, Irvin, Alonzo, & Tindal, 2013). The researchers found strongest alignment with Standard Three (Phonics and Word Recognition) expectations for the types of words students should know how to read in Kindergarten and regularly spelled one-syllable words in Grade 1.

Growth on the measures in Kindergarten and Grade 1 has been reported by Lai, Nese, Jamgochian, Alonzo and Tindal (2010) who "used a two-level hierarchical linear growth model to represent student reading growth within one academic year, with time at level-1 and student at level-2" (p. 7). Reliability of the slope for letter names, word reading fluency, and passage reading fluency measures has also been documented by Patarapichayatham, Anderson, Irvin, Kamata, Alonzo, and Tindal (2011); all coefficients were well above .71 and most were above .81.

Analyses

Two different analyses were used in this study of early literacy. In Study 1, we focused only on Kindergarten students and administered a behavior rating scale and three skill measures. We began with an exploratory factor analysis (EFA) of an Oregon data set and then developed a structural equation model (SEM) using two types of behavior from the rating scale (social and task oriented) to explain the development of skill proficiency (comprised of letter sound fluency, letter naming fluency, and phoneme segmenting fluency). The SEM was conducted with the

three factors identified in the exploratory factor analysis. Finally, we have displayed histograms for each of the reading skills to highlight the significant amount of change in skill over time.

In Study 2, we conducted hierarchical linear modeling (HLM; Raudenbush & Bryk, 2001) using demographic covariates available in the extant database to characterize their influence on students' initial status for the Letter Sounds and Phoneme Segments benchmark measures for Kindergarten, and Letter Sounds and Word Reading Fluency for Grade 1 students. We used HLM version 6.08 to estimate all models. We first examined unconditional models (without predictors but with time metric variable) to examine mean and variance of within-subject reading fluency and to provide baseline statistics for evaluating subsequent conditional models (Raudenbush & Bryk, 2002). The two parameters of interest in level-1 represented intercept and slope, with slope centered on the fall performance in the grade level (first progress measure in September) and slope expressed as the weekly increase over the year. We first examined fixed effects and then random effects with an alpha level set at .05.

We ran conditional models at level-2 to determine the influence of four student characteristics on both the intercept and slope: (a) student sex, with female = 0, male = 1; (b) program placement, with general education = 0 and special education = 1; (c) student ethnicity-race, with White = 0 and Non-White = 1; and (d) English language learner (ELL) status, with English speaker = 0 and English language learner = 1. After documenting descriptive statistics for the measures and the student characteristics, we ran a two-level hierarchical linear growth model.

Unconditional Models:

Level 1 $Y_{ti} = \pi_{0i} + \pi_{1i}(time) + e_{ti}$

Level 2 $\pi_{0i} = \beta_{00} + r_{0i}$

$\pi_{1i} = \beta_{1i} + r_{1i}$

Conditional Models:

Level 1 $Y_{ti} = \pi_{0i} + \pi_{1i}(time) + e_{ti}$

Level 2 $\pi_{0i} = \beta_{00} + \beta_{01}(Sex) + \beta_{02}(Disability) + \beta_{03}(Ethnicity) + \beta_{04}(ELL) + r_{0i}$

$\pi_{1ib} = \beta_{10} + \beta_{11}(Sex) + \beta_{12}(Disability) + \beta_{13}(Ethnicity) + \beta_{14}(ELL) + r_{1i}$

where:

Y_{ti} is the outcome (i.e., assessment score) at time *t* for student *i*
π_{0i} is the status of student *i* at the first measurement occasion
π_{1i} is the linear growth rate over time for student *i*
β_{01} to β_{05} are the coefficients for student characteristics and measurement conditions for intercept
β_{11} to β_{15} are the coefficients for student characteristics and measurement conditions for slope
e_{ti} is a residual term representing unexplained student variation from the latent growth trajectory

Results

Results are organized into two studies. In Study 1, we present the results of the two factor analyses conducted with Kindergarten students participating in a state pilot of readiness assessment. Then, in Study 2, we summarize the descriptive statistics (histograms) and present the HLM analysis results for both Kindergarten and Grade 1 students using the national sample participating in the district version of easyCBM.

Study 1: Kindergarten Readiness

In Table 2 we present descriptive statistics for the kindergarten students who participated in the readiness assessment. Results are presented for each item on the 17-item survey completed by teachers and for the three reading tests that they administered. Prior to performing the EFA, we imputed missing values and analyzed the correlation matrix among all items. All correlations ranged from low moderate to moderately high. We also analyzed the reliability of

the survey and found the total scale highly reliable (.93 for Cronbach's alpha) with high item-total correlations.

Note that in Study 1 we included a random sample of one-third of the students for conducting the exploratory factor analysis and the entire pilot population in our SEM analyses. In Table 3, we present the results from the factor analysis in which we used principal axis analysis with promax rotation using SPSS version 21. The results reflected the presence of three factors with eigenvalues exceeding 1, explaining 55%, 12%, and 6% of the variance respectively. An inspection of the scree plot showed a clear break after the third component. The first factor addressed items on the survey focusing on task behaviors (completing work, responding to teachers, being successful on task completion, following directions, returning to tasks, concentrating on tasks, taking time to do best work, finding and organizing materials, and attempting to complete tasks). The second factor addressed social behaviors (and self regulatory behavior) such as taking turns, complying with others, sharing, cooperating, checking for errors, not fussing, and exhibiting verbal or social hostility). Note that in Table 4, these behaviors are negatively scaled due to the two hostility items; also note that these items cross-loaded onto the task behaviors. Finally, the three skill behaviors of letter naming, letter sounding, and phoneme segmenting comprised the third factor and also cross-loaded onto the task behaviors. The factor correlation matrix showed correlation of .66 between the two (rated) behavior factors, .34 between social behavior and skill, and .04 between skill and task behaviors.

Based on these results, we conducted a confirmatory factor analysis in which we posited that both types of (rated) behaviors, social and task oriented, produced readiness to learn. When we ran the initial model with all items, we found poor fit for the two hostility items and so removed them from the model. We present the standardized regression weights for these items

in Table 5. Of note are the high values for items on the two behavior dimensions and letter sounds on the skill behavior. The model resulted in a significant chi-square of 1383.784 (*df* = 132); RMSEA was .088.

Study 2: Change in Performance Over Time

The previous analyses were with a pilot sample of students being assessed at the beginning of kindergarten to assess their 'readiness." In this next analysis, we included a national sample of students being assessed at a fall, winter, and spring benchmark using the same measures in Kindergarten; we also add a group of students in Grade 1 being assessed at the same benchmarks but with Letter Sounds and Word Reading Fluency.

The first depiction of growth within the school year is represented in Figures 3 and 4 for Kindergarten and first grade students, respectively. The distributions for the two measures administered at all three time periods in Kindergarten, Letter Sounds and Phoneme Segments, change dramatically in the course of each trimester. Both distributions change from a highly positively skewed and leptokurtic shape in the fall to nearly normal by spring. In contrast, for students in Grade 1, Letter Sounds begins somewhat normally distributed in the fall (as it was in the spring for students in Kindergarten) and simply maintains this shape over the course of the school year. The Word Reading Fluency distribution moves from a positively skewed and leptokurtic shape to one that is slightly positively skewed (and somewhat platykurtic). In Table 6, we display the descriptive statistics for this varying group of students who have been measured at least once in their grade level.

Given that these distributions are comprised of different groups of students taking the test at each time period (i.e., some took one, two, or all three measures as they moved in and out of

their respective districts), the critical question is about change when controlling for individual performance at each of these time periods.

In Tables 7-14, we present the results for two-level HLM analyses, focusing on the influence of student characteristics on letter sounds and phoneme segments for Kindergarten, and letter sounds and word reading fluency for Grade 1. In the analysis for Kindergarten letter sound measures, the population of 4,615 students tested within the year was comprised of 52% female, 9% with disability, 38% Non-White, and 11% English language learners. Note that the phoneme segments measure was administered to only 4,611 students. In Grade 1, 4,703 students took the letter sound test with 50% females, 11% with disability, 40% Non-White, and 13% ELL; for word reading fluency, the total number of students was 4,724

Kindergarten letter sounds. Results of the baseline (unconditional) model showed that the average letter sound fluency across all Kindergarten students was 6.53 letter sounds correct per minute (lscpm). On average, students' letter sound scores increased 0.72 lscpm each week. Deviance was 80894.66 with six estimated parameters. See Table 7.

Controlling for student demographic characteristics, the average letter sound fluency across all Kindergarten students was 8.32 lscpm, $t(4610) = 29.36$, $SE = .28$, $p < .001$. All student characteristics were significantly and negatively related to the intercept: (a) sex, $t(4610) = -2.09$, $SE = .28$, $p < .05$, (b) disability, $t(4610) = -7.44$, $SE = .46$, $p < .001$, (c) ethnicity, $t(4610) = -3.51$, $SE = .38$, $p < .01$, and (d) ELL, $t(4610) = -12.80$, $SE = .40$, $p < .001$. When controlling for all other student characteristics, on the fall benchmark, male students averaged nearly 1 less letter sound compared to females, students in special education scored on average about 3 fewer letter sounds compared to students in general education, Non-White students scored just over 1 less

letter sound compared to White students, and English language learners scored more than 5 fewer letter sounds per minute compared to native English speaking students.

The average overall slope was 0.74 lscpm growth per week, controlling for all student characteristics, $t(4610) = 67.24$, $SE = .01$, $p < .001$. Only one student characteristic significantly affected the slope of letter sound improvement over time: disability, $t(4610) = -10.64$, $SE = .02$, $p < .001$. When controlling for all other characteristics, students receiving special education instruction grew at a weekly rate of 0.52 lscpm compared to general education students. As random effects, the variances of the intercept and slope varied significantly between students in the conditional model. Deviance was 80,491.37 with 14 estimated parameters; this model was significantly different than the baseline model, $X^2 = 403.29$, $df = 8$, $p < .001$. See Table 8.

Kindergarten phoneme segments. Results of the baseline model showed that the average phoneme segmenting fluency across all Kindergarten students was 11.35 phonemes correct per minute (pcpm). On average, students' phoneme segmenting scores increased 0.76 each week. Deviance was 87104.99 with six estimated parameters. See Table 9.

The average phoneme segmenting fluency across all Kindergarten students was 14.46 pcpm when student characteristics were included in the model, $t(4606) = 35.41$, $SE = .41$, $p < .001$ (Table 10). All four student characteristics were significantly related to the intercept, each having a negative influence: (a) sex, $t(4606) = -2.25$, $SE = .49$, $p < .05$, (b) disability, $t(4606) = -11.11$, $SE = .66$, $p < .001$, (c) ethnicity, $t(4606) = -3.40$, $SE = .55$, $p < .01$, and (d) ELL, $t(4606) = -15.14$, $SE = .58$, $p < .001$. When controlling for all other student characteristics on the fall benchmark, on average, male students identified 1 less phoneme correctly compared to females, students in special education identified on average just over 7 fewer phonemes compared to students in general education, non-white students identified almost 2 fewer

phonemes compared to white students, while English language learners identified almost 9 fewer phonemes per minute compared to native English speakers.

The average overall slope was 0.80 pcpm growth per week, controlling for all student characteristics, $t(4606) = 59.03$, $SE = .01$, $p < .001$ (Table 10). Three of four student characteristics significantly predicted the slope of phoneme segment improvement over time: (a) sex, $t(4606) = -3.00$, $SE = .02$, $p < .01$, (b) disability, $t(4606) = -9.35$, $SE = .03$, $p < .001$, and (c) ELL, $t(4606) = 2.85$, $SE = .03$, $p < .01$. On average, when controlling for all other characteristics, male students grew at a weekly rate of .75 phonemes per minute, students receiving special education services grew at a weekly rate of .55 phonemes per minutes, while English language learners demonstrated a higher weekly rate of phoneme segmenting growth relative to native English speakers of .88. Analyzing random effects, the variances of the intercept and slope varied significantly between students in the conditional model. Deviance was 86434.21 with 14 estimated parameters. The conditional model yielded a significantly better fit than the baseline model, $X^2 = 670.78$, $df = 8$, $p < .001$. See Table 10.

First grade letter sounds. Results of the baseline model showed that the average letter sound fluency across all Grade 1 students was 29.22 lscpm. On average, students' letter sound scores increased 0.72 lscpm each week. Deviance was 96.859.30 with six estimated parameters. See Table 11.

Controlling for student characteristics, the average letter sound fluency across all first grade students was 32.11 lscpm, $t(4698) = 101.84$, $SE = .32$, $p < .001$. Three of four student characteristics significantly and negatively predicted the intercept: (a) sex, $t(4698) = -3.18$, $SE = .39$, $p < .01$, (b) disability, $t(4698) = -15.53$, $SE = .65$, $p < .001$, and (c) ELL, $t(4698) = -9.74$, $SE = .65$, $p < .001$. Male students averaged about 1 less letter sound compared to females,

students in special education scored on average about 10 fewer letter sounds compared to students in general education, while English language learners scored on average just over 6 fewer letter sounds correct per minute compared to native English speaking students on the fall benchmark, controlling for all other student characteristics.

The average overall slope was 0.48 lcpm per week, controlling for all student characteristics, $t(4698) = 44.27, SE = .01, p < .001$. Two of the four student characteristics were significantly related to the slope of letter sound growth over time in first grade: (a) disability, $t(4698) = 2.14, SE = .02, p < .05$, and (b) ELL, $t(4698) = 6.62, SE = .02, p < .001$. When controlling for all other characteristics, students receiving special education services showed a higher rate of growth compared to general education students, growing at a weekly rate of .53 letter sounds per minute. Similarly, English language learners grew at an average weekly rate of .64; this growth was .16 letters sounds higher than native English speakers when controlling for all other student characteristics. Random effects variances for the intercept and slope varied significantly between students in the conditional model. Deviance was 96360.88 with 14 estimated parameters; this model was significantly different than the baseline model, $X^2 = 498.43$, $df = 8, p < .001$. See Table 12.

First grade word reading fluency. Results of the baseline model showed that the average word reading fluency across all Grade 1 students was 14.22 words correct per minute (wcpm). On average, students' word reading scores increased 0.89 wcpm each week. Deviance was 102539.18.99 with six estimated parameters. See Table 13.

The average word reading fluency across all first grade students was 17.20 wcpm when student characteristics were included in the model, $t(4719) = 34.20, SE = .50, p < .001$. Three of four student characteristics were significantly and negatively related to the intercept: (a)

disability, $t(4719) = -12.54$, $SE = .67$, $p < .001$, (b) ethnicity, $t(4719) = -2.01$, $SE = .69$, $p < .05$, and (c) ELL, $t(4719) = -9.83$, $SE = .73$, $p < .001$. When controlling for all other student characteristics, students in special education identified on average just about 8 fewer wcpm compared to students in general education, Non-White students identified about 1 fewer wcpm compared to White students, while English language learners identified about 7 fewer wcpm compared to native English speakers on the fall benchmark.

The average overall slope for the word reading fluency measure was 0.95 wcpm growth per week, controlling for all student characteristics, $t(4719) = 74.23$, $SE = .01$, $p < .001$. Two of four student characteristics significantly predicted and negatively influenced the slope of word reading improvement over time: (a) disability, $t(4719) = -13.25$, $SE = .02$, $p < .001$, and (b) ELL, $t(4719) = -3.03$, $SE = .03$, $p < .01$,. On average, when controlling for all other characteristics, students receiving instruction in special education grew at a weekly rate of .64 wcpm, while English language learners demonstrated a slightly lower weekly rate of word reading growth relative to native English speakers of .87. Analyzing random effects, the variances of the intercept and slope varied significantly between students in the conditional model. Deviance was 102141.80 with 14 estimated parameters. The conditional model resulted in a significantly better fit as compared to the baseline model, $X^2 = 397.37$, $df = 8$, $p < .001$. See Table 14.

Discussion

The most significant findings from this study on early literacy involve the uniformity of the readiness assessment, the amount of change within the year, and the critical nature of student characteristics that influence growth. When students enter our educational system, two types of behaviors, social and task oriented, appear to be critical in demonstrating skills in early literacy. Although the legislative mandates may be to ensure all students are ready to learn, this issue may

pale in the change over the year that reflects learning to read. In documenting several thousand students from across the United States, it was apparent that students arrive in our schools with low levels of performance but learn at an incredible rate. Although the distributions were positively skewed in the fall (most students performed in the low end), by the spring of the academic year, the distributions were normal.

When measuring students' growth within individuals, rather than across groups of students, the results reflect an intercept of about 7 letter sounds with a slope of .75 per week for Kindergarten students; student characteristics, particularly receipt of special services, influences both this level and the slope of improvement. For phoneme segments in Kindergarten, the intercept was 11 phonemes at the beginning of the year with .76 phonemes growth per year when controlling for all student characteristics. Again, both intercept and slope were influenced by student characteristics, particularly disability and sex. Finally for the students in Grade 1, the same outcomes were found with both letter sounds and word reading fluency. In the former measure, the intercept was 30 letters correct per minute (controlling for student characteristics) and improved at a rate of about one half word per week; disability again was influential. With word reading fluency, the base rate of 14 words correct per minute were found with nearly 1 word per week in slope when controlling for student characteristics. Although all student characteristics but sex were influential in the intercept, disability and ELL status were influential in growth.

Limitations and Conclusions

The most significant limitation of this study is the convenience sample that was used. This sample, including the lack of complete demographic information, likely influenced the final outcomes. It is unlikely that the data were missing completely at random. As school districts

begin to systematize their assessment reforms, it is critical to measure the right constructs and attend to the right outcomes.

Conclusion

Our results indicated that readiness may be more social-behavioral than academic, and this hypothesis merits exploration in future empirical research. The model we posited provided a significant model of literacy with both social and task oriented behaviors being important in literacy. Nevertheless, this readiness is only determined at one point in time and as we found, it is the change over time that is so significant. As legislature focuses on Kindergarten readiness for all students, the onus is on researchers to help guide this focus, better define readiness, and meet the policy demands to prepare students, teachers, and school systems.

References

Alonzo, J., & Tindal, G. (2007a). The development of early literacy measures for use in a progress monitoring assessment system: Letter names, letter sounds and phoneme segmenting (Technical Report No. 39). Eugene, OR: Behavioral Research and Teaching, University of Oregon.

Alonzo, J., & Tindal, G. (2007b). The development of word and passage reading fluency measures in a progress monitoring assessment system (Technical Report No. 40). Eugene, OR: Behavioral Research and Teaching, University of Oregon.

Alonzo, J., & Tindal, G. (2009). Alternate Form and Test-Retest Reliability of easyCBM Reading Measures (Technical Report No. 0906). Eugene, OR: Behavioral Research and Teaching, University of Oregon. .

Anderson, D., Park, B., Lai, C., Alonzo, J., & Tindal, G. (2012). An examination of test-retest, alternate form reliability, and generalizability theory study of the easyCBM reading Assessments: Grade 1. Eugene, OR: Behavioral Research and Teaching.

Anderson, R. C., Hiebert, E. H., Scott, J. A., & Wilkinson, I. A. G. (1985). Becoming a Nation of Readers: The Report of the Commission on Reading. Washington, DC: National Institute of Education.

Anderson, V. L., & Tinker, M. A. (1936). The speed factor in reading performance. *Journal of Educational Psychology, 27*(8), 621-624. doi: 10.1037/h005670

Ardoin, S. P., & Christ, T. J. (2008). Evaluating curriculum-based measurement slope estimates using data from triannual universal screenings. *School Psychology Review, 37*(1), 109-125.

Christ, T. J., Silberglitt, B., Yeo, S., & Cormier, D. (2010). Curriculum based measurement of oral reading: An evaluation of growth rates and seasonal effects among students served in general and special education. *School Psychology Review, 39*(3), 447-462.

Committee on Education and Labor. (2001). No Child Left Behind (1st ed.). Washington, DC, USA: Government Printing Office.

Deno, S., Fuchs, L. S., Marston, D., & Shin, J. (2001). Using curriculum-based measurement to establish growth standards for students with learning disabilities. *School Psychology Review, 30*(4), 507-524.

Deno, S., Mirkin, P., Chiang, B., & Lowry, L. (1980). Relationships among simple measures of reading and performance on standardized achievement tests. Minneapolis, MN: Institute for Research on Learning Disabilities (IRLD), University of Minnesota.

Fuchs, L. S., Fuchs, D., & Compton, D. L. (2004). Monitoring early reading development in first grade: Word identification fluency versus nonsense word fluency. *Exceptional Children, 71*(1), 7-21.

Graney, S. B., Missall, K. N., Martínez, R. S., & Bergstrom, M. (2009). A preliminary investigation of within-year growth patterns in reading and mathematics curriculum-based measures. *Journal of School Psychology, 47*(2), 121-142.

LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology, 6*(2), 293-323. doi: 10.1016/0010-0285(74)90015-2

Lai, C. F., Nese, J. F. T., Jamgochian, E. M., Alonzo, J., & Tindal, G. (2010). *Technical adequacy of the easyCBM primary-level reading measures (grades K-1), 2009-2010 version* (Technical Report No. 1003). Eugene, OR: Behavioral Research and Teaching, University of Oregon.

Linklater, D. L., O'Connor, R. E., & Palardy, G. J. (2009). Kindergarten literacy assessment of English Only and English language learner students: an examination of the predictive validity of three phonemic awareness measures. *Journal of School Psychology, 47*(6), 369–394. doi: 10.1016/j.jsp.2009.08.001

National Institute for Literacy. (2008). Developing early literacy: Report of the National Early Literacy Panel (A scientific synthesis of early literacy development and implications for intervention). Washington, DC.

National Institutes of Child Health and Human Development. (2000). Report of National Reading Panel: Teaching children to read: An evidence-based assessment of the scientific literature on reading and its implications for reading instruction *Report of the Subgroups*. Washington, DC.

Nese, J. F. T., Biancarosa, G., Anderson, D., Lai, C.-F., Alonzo, J., & Tindal, G. (2012). Within-year oral reading fluency with CBM: A comparison of models. *Reading and Writing: An Interdisciplinary Journal, 25*(4), 887-915.

Oregon Department of Education. (2013). Executive Numbered Memo: 010-2012-13 – OAR 581-022-2130-Kindergarten Assessment (Vol. OAR-581-022-2130). Salem: Oregon Legislature.

Patarapichayatham, C., Anderson, D., Irvin, P. S., Kamata, A., Alonzo, J., & Tindal, G. (2011). easyCBM slope reliability: Letter names, word reading fluency, and passage reading fluency (Technical Report No. 1111). Eugene, OR: Behavioral Research and Teaching, University of Oregon.

Raudenbush, S. W., & Bryk, A. S. (2001). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods (2nd ed.)*. Thousand Oaks, CA: Sage.

Ritchey, K. D. (2008). Assessing letter sound knowledge: A comparison of letter sound fluency and nonsense word fluency. *Exceptional Children, 74*(4), 487-506.

Ritchey, K. D., & Speece, D. L. (2006). From letter names to word reading: The nascent role of sublexical fluency. *Contemporary Educational Psychology, 31*(3), 301-327.

Sáez, L., Irvin, P., Alonzo, J., & Tindal, G. (2012). Phoneme segmenting alignment with the common core foundational skills standard two:

Grades K-1 (Technical Report No. 1005). Eugene, OR: Behavioral Research and Teaching.

Sáez, L., Irvin, P. S., Alonzo, J., & Tindal, G. (2013). Alignment with the Common Core State Standards: easyCBM K-3 Word Reading (Technical Report No. 1303). Eugene, OR: Behavioral Research and Teaching, University of Oregon.

Speece, D. L., Ritchey, K. D., Cooper, D. H., Roth, F. P., & Schatschneider, C. (2004). Growth in early reading skills from kindergarten to third grade. *Contemporary Educational Psychology, 29*, 312-332. doi: 10.1016/j.cedpsych.2003.07.001

Stage, S., Sheppard, J., Davidson, M., & Browning, M. (2001). Prediction of first-graders' growth in oral reading fluency using kindergarten letter fluency. *Journal of School Psychology, 39*, 225–237. doi: 10.1016/S0022-4405(01)00065-6

Tindal, G. (2013). Curriculum-based measurement: A brief history of nearly everything from the 1970s to the present. *ISRN Education (International Scholarly Research Network), 29*. doi: 10.1155/2013/958530

Wayman, M. M., Wallace, T., Wiley, H. I., Tich'a, R., & Espin, C. (2007). Literature synthesis on curriculum-based measurement in reading. *The Journal of Special Education, 41*(2), 85-120. doi: 10.1177/00224669070410020401

Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. *Child Development, 69*, 848-872.

Table 1

Distribution of Students in Districts, Buildings, and Teachers In Study 1

Districts	Count	Buildings	Count	Teachers	Count
District 1	18	Building 1	1	Teacher 1	18
District 2	21	Building 2	18	Teacher 2	21
District 3	45	Building 3	21	Teacher 3	23
District 4	46	Building 4	23	Teacher 4	24
District 5	56	Building 5	24	Teacher 5	24
District 6	59	Building 6	24	Teacher 6	24
District 7	63	Building 7	24	Teacher 7	25
District 8	69	Building 8	25	Teacher 8	26
District 9	81	Building 9	26	Teacher 9	26
District 10	82	Building 10	26	Teacher 10	26
District 11	89	Building 11	26	Teacher 11	26
District 12	96	Building 12	26	Teacher 12	27
District 13	133	Building 13	27	Teacher 13	27
District 14	171	Building 14	27	Teacher 14	27
District 15	198	Building 15	27	Teacher 15	27
Ave count	81.8	Building 16	27	Teacher 16	28
		Building 17	27	Teacher 17	29
		Building 18	28	Teacher 18	30
		Building 19	29	Teacher 19	40
		Building 20	30	Teacher 20	40
		Building 21	31	Teacher 21	42
		Building 22	31	Teacher 22	45
		Building 23	40	Teacher 23	46
		Building 24	40	Teacher 24	48
		Building 25	42	Teacher 25	48
		Building 26	45	Teacher 26	51
		Building 27	46	Teacher 27	59
		Building 28	48	Teacher 28	59
		Building 29	48	Teacher 29	63
		Building 30	51	Teacher 30	78
		Building 31	59	Teacher 31	120
		Building 32	63	Ave count	38.61
		Building 33	78		
		Building 34	120		
		Ave count	36.12		

Table 2

Descriptive statistics for kindergarten students in readiness assessment

Measure and (label used in EFA and CFA analyses)	Mean	*SD*	*N*
Letter Sounds (lsf)	7.31	10.185	380
Letter Names (lnf)	17.88	15.593	380
Phoneme Segments (phseg)	9.40	13.037	380
Observes Rules and Follow Directions (follow)	3.59	.971	380
Completes Tasks with 2+ Steps (complete)	3.64	.976	380
Successfully Completes Tasks (success)	3.66	.900	380
Attempts New Challenging Tasks (attempt)	3.62	.946	380
Concentrates Working on Tasks (concentrate)	3.37	.994	380
Responds to Instruction; initiates (respond)	3.53	.972	380
Takes Time to Best Work (time)	3.66	.918	380
Finds and Organizes Material (finds)	3.63	.859	380
Sees Own Errors and Corrects (errorchck)	2.90	.959	380
Returns to Unfinished Tasks (return)	3.49	.902	380
Shares Toys; No Fighting (share)	3.95	.830	380
Expresses Verbal Hostility (vhostile)	1.42	.815	380
Expresses Physical Hostility (phostile)	1.38	.791	380
Cooperates with Others (cooperate)	3.91	.861	380
Takes Turns (turns)	3.93	.806	380
Complies with Adult Directives (comply)	4.03	.900	380
Does Not Fuss and Waits (nofuss)	3.91	1.007	380