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Network Analysis of Beginning Reading Instruction

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Abstract

Network text analysis was used to identify underlying reading concepts in a kindergarten general education literacy instruction classroom (*n*=23) based on naturalistic observations. Using data from three observations, we studied how reading concepts were connected and how their presence changed over time as represented by nodes and links on structural network maps. Most concepts were related to text- and word-based activities. Others were related to letter sounds, phonemes, and concepts of print activities. Although many concepts were inter-related and were present across time, the network maps changed. There was moderate consistency of general concepts in early reading instruction. The underlying structure of beginning reading instruction captured in this study contributed to deeper understanding of emerging literacy skills growth in kindergarten.

Network Analysis of Beginning Reading Instruction

Current Response to Intervention (RTI) approaches for preventing reading difficulties typically assess skill fluency three times a year to indicate student performance levels and evaluate skill growth for determining adequate yearly progress (e.g., Fuchs & Fuchs, 2004). With multiple time point data collected across the year, trajectories of performance can be monitored to support student learning. For example, increases in growth slope are assumed to reflect improvements in learning whereas decreases in performance or lack of growth are believed to signal the need for more intensive instruction. However, the concept of fluency growth remains unclear because the specific instructional factors that contribute to observed gains in slope are poorly understood. In other words, what specific instructional elements promote fluency skill growth?

Our inability to precisely pinpoint critical contributors to fluency growth weakens our capability for promoting efficient learning for all students. Particularly in the early grades, developing skill fluency is an important component of instruction because it enables more efficient accurate performance that can be maintained over time (Binder, 1996). Teachers in kindergarten are uniquely positioned to influence later reading outcomes because they introduce a host of foundational skills necessary for scaffolding reading development. Like other researchers (e.g., Ritchey & Speece, 2006), we believe that a better understanding of the role of growth for developing beginning reading skills is necessary. Therefore, in this study we examined the link between patterns in beginning reading skills instruction in kindergarten and classroom gains found on fluency measures to provide a richer understanding of how classroom instruction impacts fluency growth. First, we review the literature on beginning literacy instruction to provide a theoretical context in which to interpret the instructional activities we observed. Second, we describe the network analysis method used to empirically analyze skill instruction patterns over time.

Exemplary Beginning Reading Instruction

A number of studies have examined beginning reading teacher practices through self-report. For example, by surveying 86 teachers nominated as *exemplary*, Pressley, Rankin, and Yokoi (1996) reported different literacy instructional methods employed in kindergarten, first grade, and second grade. All kindergarten teachers reported using songs to help solidify skills and knowledge. Sixty-five percent used drills (i.e., isolated practice) to teach letter recognition, and 100% taught students to focus on the sounds in words to facilitate letter sound knowledge. All kindergarten teachers also reported educating students about the concept of a letter, and 96% reported teaching print directionality. Teachers also frequently reported teaching students how to use picture cues (96%), sound out words (92%), and recognize context clues (98%) for understanding story meaning. Nearly 90% of kindergarten teachers reported balancing isolated practice opportunities with activities that were embedded within the context of a story. In other studies, kindergarten teachers have reported similarly blended practices, providing both explicit and systematic instruction in word decoding and alphabetic knowledge, as well as literature-rich lessons to support comprehension (e.g., Baumann, Hoffman Duffy-Hester, & Moon Ro, 2000; Xue & Meisels, 2004).

Classroom observation studies provide more specific examples of how teacher instruction may promote student growth. For example, Taylor and colleagues found that for kindergarten students, teacher telling of information to be learned (rather than coaching or engaging students) was negatively associated with spring letter naming, phonemic awareness, and word dictation scores (Taylor, Peterson, Pearson, & Rodriguez, 2002). Furthermore, time spent on word learning activities was positively associated with spring letter naming fluency scores. In one of the most comprehensive studies of kindergarten instruction and growth to date, thrice measured student fluency scores were examined in addition to systematic literacy instruction observation data drawn from 17 Reading First classrooms (Al Otaiba, Connor, Lane, Kosanovich, Schatschneider, Dyrlund et al., 2008). Al Otaiba et al. (2008) reported that, on average, among these teachers who were rated as generally effective, for a 60 minute observation, 30 minutes were spent on phonological awareness/phonics instruction and 15 minutes were spent each on vocabulary and comprehension instruction, reflecting a variety of skills across the spectrum of "code-focused" (e.g., letter and word identification) and "meaningful" text-based activities. In general, students in these classes demonstrated increases in letter naming fluency of 30 letters and initial sound recognition of 14.6 phonemes from fall to spring (Al Otaiba, 2008). Moreover, greater letter naming/decoding fluency growth was associated with higher frequency of meaningful text-based activities, such as reading aloud with diverse texts, and checking for text understanding by asking questions.

In contrast to the finding reported by Taylor et al. (2002), Al Otaiba et al. (2008) did not find that instructional time variables reliably predicted letter naming/decoding fluency growth. This suggests that the amount of time spent on any particular activity may not necessarily directly promote fluency growth. Although not tested, it may have been that the *consistency* of teacher practice (rather than merely time spent) promoted the student growth found. For example, although teacher practices varied, very consistent within-teacher practices were evidenced by a lack of significant changes in computed slopes across teachers (Al Otaiba, 2008). To our knowledge, the extent to which teacher practices are consistent over time has not been investigated as a potential support of skill fluency growth. We investigated instructional consistency in this study by utilizing an innovative method of analysis called network text analysis (NTA) to empirically describe how different instructional activities implemented for literacy skill building were linked, and how these instructional skill "networks" changed over time.

Network Text Analysis

Network Text Analysis (NTA) is a method used to encode the relationships between words in a text to construct a network of linked words (Popping, 2000). NTA can be used to extract networks from texts (Carley, 1997) and has been applied in studies to identify the central components and linkages between words in texts in various contexts. For example, White and Dandi (2009) applied NTA to study the mission statements of 50 Catholic health systems and showed the relational structure of concepts within the mission statements and the variation among Catholic health systems. Similarly, Grbic, Hafferty, and Hafferty (2013) used NTA to explore the core concepts embedded within a medical school's mission statement. In both studies, identified core concepts were reported using network measures such as *centrality* (concepts with high centrality typically occupy strategic locations in the network) and *density* (concepts with high density have more direct ties with other concepts, regardless of directionality). In addition to identifying concepts within the larger networks, the authors were also able to capture differences within subsets of mission statements that varied by institution type (private versus public medical schools; Catholic Healthcare Partners versus St. Raphael Healthcare System).

In this study, we used NTA as a tool for extracting patterns among taught skills observed during kindergarten literacy instruction in a general education setting. As part of a larger weekly observational research endeavor, in this particular study we focus on one teacher and three days of instruction across three months identified in the reading curriculum as sharing similar instructional routines. By mapping out the content covered during instructional lessons observed (i.e., creating a structural network of skills and knowledge taught), we examined how literacy concepts were linked and how their presence changed over time. Similar to the NTA literature in other fields, we examined the centrality and density within our networks as well as the overlap between them to provide evidence of instructional consistency, which we relate to gains in student performance across a variety of beginning reading fluency measures (i.e., letter sounds, phoneme segmenting, and word reading). We had the following research questions:

1. What are the main beginning reading concepts that underlie spring kindergarten general education literacy instruction? How are these concepts related to each other as part of an instructional network map?
2. To what extent do instructional network maps stay consistent or change over time?

Methods and Data Sources

In the following section, we describe the sample, setting, and research procedures we used in this study.

Teacher Information/Curriculum

The female teacher in this study taught morning half-day kindergarten in a general education classroom using Houghton-Mifflin curricular materials (see Table 1 for published target skill objectives). She had five years of teaching experience at the time of the study. The Oregon school in which she taught was a public school that served kindergarten through fifth grade students in a semi-rural district. This teacher was observed regularly implementing both small-group and whole-class literacy instruction, although we focused on the latter for this study. School district policy required that all students receive benchmark fluency testing three times a year as part of its RTI plan. Assessments administered were part of the easyCBM system (Alonzo, Tindal, Ulmer, & Glasgow, 2006).

Students

Twenty-three students were observed as part of this study, including 13 girls and 10 boys. At the time of the study, three students had been identified as needed more intensive intervention.

Procedures

The teacher's instruction was observed four times a month on 14 separate occasions for approximately one hour each between January - May 2012. For each observation, the first and second authors were stationed on opposite sides of the classroom and took both transcript and detailed moment-by-moment notes on classroom activities using laptop computers. Observations included both small-group instruction (n = 5) and whole-class instruction (n =23), for 30 minutes each. For this study we analyzed notes recorded during whole class instruction, in which students were seated on a large carpet at the front of the room. The teacher typically sat on a chair facing them, and employed large books, charts, and songs to facilitate her instruction.

Data Sources

Three types of data sources were collected: classroom observation notes, published reading curriculum materials for each day of instruction observed, and kindergarten-level beginning reading fluency scores. Classroom observation notes for the whole-class instruction included one day each in March, April, and May (Week 1 Day 3 materials; see Table 1 for details). Due to extended teacher illness, we were unable to observe a corresponding day in February. Fluency assessments were administered in January and May of the same year.

Growth Measures

The easyCBM® kindergarten letter sounds, phoneme segmenting, and word reading fluency benchmark measures were individually administered to all students by the same school-staff examiners in January and May. These measures were scaled to be of equivalent difficulty using a Rasch model (Alonzo & Tindal, 2007).

Letter sounds fluency. The letter sounds fluency (LSF) measure tests students' ability to identify the sounds associated with the letters of the English alphabet, both in their lower case and capitalized forms. In this individually-administered measure, students are shown a series of letters organized in a chart on one side of a single sheet of paper and given 60 seconds to name as many of them as they can. A trained assessor follows along as the student produces the sounds associated with each of the letters, indicating on his/her own test protocol each letter for which the student fails to correctly identify the sound and prompting the student to go on if he/she hesitates at a letter for more than three seconds. Student self-corrections are counted as correct responses. At the end of the allotted time, the assessor marks the last letter sound produced and calculates the total number of letter sounds produced correctly to arrive at the student's score, letter sounds produced correctly in one minute.

Phoneme segmenting fluency. The phoneme segmenting fluency (PSF) measure tests students' ability to segment a word into its constituent phonemes. In this individually-administered measure, test administrators follow a standard written protocol on which is listed a series of words. They say each word aloud, asking students to segment the word into its individual phonemes. As students finish segmenting one word, test administrators provide the next word verbally, repeating this sequence for 60 seconds as students segment as many words into phonemes as they can. As students say the phonemes, assessors indicate on their own test protocol each phoneme the student correctly segments. Student self-corrections are counted as correct responses, and students are prompted to go on if they hesitate for more than three seconds. At the end of the allotted time, the assessor marks the last phoneme produced and calculates the total number of phonemes segmented correctly to arrive at the student's score, phonemes segmented correctly in one minute.

Word reading fluency. The word reading fluency (WRF) measure tests students' ability to read both sight-words and words following regular patterns of letter/sound correspondence in the English language, allowing them to be easily decodable. In this individually-administered measure, students are shown a series of words organized in a chart on one side of a single sheet of paper and given 60 seconds to read as many of them as they can. A trained assessor follows along as the student reads the words, indicating on his/her own test protocol each word the student reads incorrectly and prompting the student to go on if he/she hesitates at a word for more than three seconds. Student self-corrections are counted as correct responses. At the end of the allotted time, the assessor marks the last word read and calculates the total number of words read correctly to arrive at the student's score, words read correctly in one minute.

Data Preprocessing

Notes from both the first and second authors were combined to construct a master set of notes for coding. A coding dictionary (see Appendix) was created to define all major beginning reading skills and knowledge recorded, and to reduce the content for analysis by using both common teaching pedagogy terms and terms drawn from the published curriculum. Because our observation notes included both verbatim, we extracted evidence of beginning reading instruction only and codes were designed to be at the same "grain size" level (i.e., 1-3 word skill codes to capture the general skills and knowledge content observed; non-reading related behaviors were not included). To ease interpretation, all skill/knowledge "concept" codes were written to be present-tense without word endings and underscoring was used to connect words that could be mistaken as separate concepts (e.g., noting details = *note_details*). Similar to its use in the NTA literature, for this study we used the word "concept" to represent both identified skills and knowledge (i.e., we did not differentiate between the two), in order to examine thematic patterns of instructional content covered. The frequency of these codes formed the basis of the NTA in that more frequently taught concepts had greater representation in the network structure. The two authors then met to discuss any similarities or differences in coding to produce the final list of coded concepts for each day of instruction observed. For example, from the original notes "*Asks students how many sounds are in hay*" was recoded to *phoneme count* because this was a specific instructional activity and "*Explained what 'quotation mark' means"* to *text COP punctuation* (*COP* = concepts of print) because this was a topic addressed within a broader instructional activity

Data Analysis

Network text analysis was used to analyze the observation notes that served as a basis for identifying relationships between instructional reading concepts. AutoMap (version 3.0.10.18, Pittsburgh, Pennsylvania) was used to convert the instructional reading concept data into a semantic network, which is essentially a central graph comprised of nodes (i.e., beginning reading concepts) and ties (i.e. relationship between these concepts) among nodes.

A given reading instructional concept was linked to another within a specific "window" size of text. The larger the window size, the greater the number of ties allowed among skills. We used AutoMap's default window size of 2 and specified sentences as the unit for analysis. Using these specifications, ties were created for every pair of skills within two sentences of each other.

We used the network analysis program Organizational Risk Analyzer (ORA; version 3.0.9.3, Pittsburgh, Pennsylvania) to visualize and analyze the resulting network. The three observation notes were analyzed as separate instructional reading concept networks to examine changes in reading skills and knowledge taught over time.

Network measures. The network for each set of observation notes was described using the number of central concepts in each network (i.e., *text*, *word*, *phoneme_segmenting*), the network link count (i.e., the number of links in the network), network density (i.e., the ratio of the number of links versus the maximum possible links for a network), and the percent of overlap between concepts. Both the network and link and density are inter-related because both measures take into account the number of links in the network. These measures indicate the centrality of the network, and higher density values indicate higher centrality, or observation note frequency. We interpret occurrences of greater centrality as indications of more cohesive instructional emphasis because they are present at a higher frequency.

Results

In this section, we report the results of our study, beginning with a general overview of the network maps, and then discussing findings for the individual maps from each of the three observational time points. In addition, we provide the results of our analyses of growth in early reading skills from start to end of the study, and discuss study limitations.

General Characteristics of Network Maps

In general, the network maps indicated that kindergarten instruction focused on about 20 different concepts in March, April, and May (see RC count, Table 2). Instructional concepts present in the networks are noted below in italics. The reading concepts most frequently found in each network were *text* and *word*, and were universal across the three months. This finding suggests that all three lessons observed were primarily composed of text-based and code-focused activities. These two concepts comprised major nodes for all three network maps (i.e., almost every other concept is connected to them). According to Figure 1, other reading concepts with high frequencies included *phoneme* and *segment* for March; *decode* for April; and *letter*, *recognize*, and *hf* (high frequency words) for May. Some reading concepts clustered to form specific regions (detailed description of these regions below). In general, there was one main network map for each month; however, in April and May there was also a disconnected smaller network (to be further discussed below).

As shown in Table 2, the link count for March (42) was higher than for April (26) and May (22), meaning that more skills and knowledge were linked to each other in March compared to the other two months. Because the network link count and density are inter-related, it was not surprising to see that the density for March was higher than April and May, reflecting greater cohesiveness of instructional concepts during that month.

In addition, across March, April, and May, the percent of concept overlap ranged from between 47% and 53% (see Table 1). This finding suggests that there was moderate consistency across the lessons for these months in the type of skills and knowledge taught. About half of the concepts emphasized for each observation were also emphasized in the other observations.

Characteristics of Individual Network Maps

March. In the network map for March, *text* was the most frequent reading concept observed. This means that the majority of instructional activities in this lesson were text-based. Many concepts were connected to *text*, including reading comprehension strategies such as *picture_clues*, *infer*, *monitor_clarify*, *main_idea*, and *note_details*. In other words, text-based instruction reflected activities in how to use story pictures as clues, inferring, monitoring and clarifying text, recognizing the main idea, and noting story details. Activities that entailed building background knowledge were related to vocabulary instruction, both of which took place within the context of story reading. In addition, instruction pertaining to punctuation (e.g., what quotation and exclamation marks are) was provided within the context of text reading.

Connected to the text node was a second region in which instructional activities emphasized high frequency word recognition and word decoding practice. Linked to the concept of *recognize*, were phoneme (segmenting and counting) and letter sound activities. *Practice* was a code we used to identify activities that were repeated; therefore, both phoneme segmenting and word recognition activities had multiple repeated opportunities for practice in the lesson observed. As shown in Figure 1a (see the node size), greater instructional emphasis was given to phonemes than to words.

In general, the lesson observed in March entailed primarily activities to support learning about reading in context, through use of a story (i.e., connected text). Students also practiced word, letter, and phoneme recognition (or decoding), but these activities played a smaller role in the lesson. Interestingly, the map reflects multiple interconnected branches for text-based activities and more sparse links for the code-focused activities, which suggests that the code-focused activities were isolated, rather than embedded in, broader literacy activities.

April. In this network map, *text* remained as the most frequent concept, as evidenced by the large size of the node. Once again, many reading comprehension strategies (e.g., *picture_clues*, *infer*, *monitor_clarify*, and *note_details)* were highly connected to this node. In addition, four new concepts emerged: building story background, understanding the difference between story realism and fantasy, drawing conclusions about a story, and sequencing story events. The role of building background was more directly related to the text, whereas in March, building background was indirectly related to text through vocabulary activities. In April, however, vocabulary instruction was more specifically focused on helping students learn the specific meaning of words in text by providing definitions. In addition, *cop* in this network was connected to more concepts than in March to form a region, including *directionality*, *capletters* (capital letters), and *punctuation*. Thus, instruction related to developing student understandings of concepts about print involved more diverse content than in the previous month.

Similar to March, *word* was connected to *high frequency* word recognition and decoding activities. The reading concept *rhyme* (activities to build rhyming sensitivity) was the only new addition connected to this node. Activities related to phonemes, on the other hand (unlike March), were distinguished from the main network to form their own small region. *Phoneme* comprised the central reading skill, and was connected to *blend*, *substitute*, and *segment* (see Figure 1b). Therefore, phoneme-related instructional activities included blending, substituting, and segmenting sound parts within words. In March, the phoneme activities were linked to the main network through their repeated practice (letter sound and word activities also employed repeated practice). However, in April, the phoneme activities took on a different form, in which students engaged in more diverse activities (blending and substitution were added) that were not repeatedly practiced.

May. Unlike the network maps for March and April where *text* and *word* were the central reading concepts, *recognize* was the most frequent and central reading concept (based on the node size). *Recognize* connected three regions: (a) *letter sound* (b) *word* activities (including high frequency word recognition and spelling) and (c) *text –based activities.* Both the *letter sound* and *word* activities regions were connected to *text* through *practice* and *read*. Similar to the previous month, because students were given multiple opportunities to practice text reading and also word and sound recognition, these activities were linked in the network. The larger size of the *recognize* node suggests that the May lesson observed primarily involved code-focused recognition, and to a lesser extent, text-based instruction.

Although less frequent than *recognize*, *text* remained central, especially in the region that connected the same reading comprehension strategies as previously observed (*picture_clues*, *infer*, *monitor_clarify*, *events_sequenc,* and *note_details*). In addition, instruction also included predicting story events and discussing the main idea. The *COP* region, which consisted of *punctuation*, story *setting*, and *author*, entailed instruction directly tied to the story. The expansion of concepts related to print and story book reading suggests that by May the teacher was introducing more sophisticated content to students, pointing how who the author was and explaining story setting.

Similar to the April network map, there was also a disconnected, smaller network that consisted of *phoneme* as the central reading concept. *Substitution* and *segment* were connected to *phoneme*, reflecting a distinct region for phoneme instructional activities (see Figure 1c). Unlike April's map, phoneme blending was not part of the lesson.

In general, letter sound and word recognition activities comprised the main focus of the lesson observed in May, with text-based activities less heavily emphasized. Phoneme activities were not related to these activities, likely due to the absence of repeated practice in segmenting and phoneme substitution (i.e., these skills were practiced, but not as intensely as in the past, as evidenced by the lack of connection with *practice*). See Figure 2 to see the changes in reading concepts (in percentage) across the months.

Alignment between the Curriculum and Observed Reading Activities

We did not observe full alignment between the curriculum and the observed activities. However, it was clear that the observed activities were not selected by the teacher at random; they corresponded with the instructional routines delineated by the published curriculum (see Table 1 for the list of skill objectives specified for each day observed). For example, instruction generally related to Concepts of Print (COP) was observed in March, but the curriculum COP targets were “first and last letters in words and recognizing words that match”, not punctuation (as was observed). That is not to say that punctuation is not a COP curriculum target—it is— for a different instructional week. In contrast, high frequency word recognition was observed and was more clearly aligned with the published curriculum’s reading objective High Frequency Words. Phonemic Awareness skills observed were represented by phoneme segmenting, but not blending, activities. The letter sound activities fit with the Phonics reading skill objective. None of the Comprehension Strategies or Skills curriculum instructional targets for this theme were found, although, as shown in the network, at least 10 different comprehension-related activities were observed.

Thus, rich instruction related to text comprehension was observed; however, it didn’t necessarily directly correspond with the published curriculum targets assigned to our observation day. Another example was observed on the curriculum on Phonemic Awareness instruction in April that emphasized “Syllables in spoken words; phoneme substitution (final)”. Although substitution was observed, we found that instruction also covered segmenting and blending. Similarly, the concept of “Sequence of Event” was the curriculum’s only targeted comprehension skills. This strategy, along with seven other skills including infer, realism_fantasy, build_background, were observed, reflecting rich instruction related to text comprehension observed in the area of comprehension skills. In general, we observed that the teacher provided rich instruction despite the lack of full alignment between the curriculum and the observed activities., Some of the weak alignment may be due to the teacher reinforcing previously-taught skills based on the needs of her students.

Connection Between Student Growth and Reading Skills Instruction

Student's scores in all easyCBM measures gathered from the online descriptions in this study showed that student performance, in general, increased from winter to spring, except for five students on the PSF measure and one student on WRF measure (see Figures 3a-d). On the LSF measure, gain scores ranged from 5 to 31 letters correct per minute (lcpm), with the average gain for the class at 16 lcpm. On the PSF measures, gain scores ranged from -5 to 33 phonemes segmented correctly per minute (pscpm), with the average gain score for the class at 17 pscpm. On the WRF measures, gain scores ranged from -17 to 41 words correct per minute (wcpm), and students gained 9.9 wcpm on average. Although students made gains across the measures, gains on the PSF measure displayed more uneven growth, compared to LSF and WRF. See Figure 3a for overall gain across the easyCBM measures.

As shown in Figure 3a, students performed relatively close to the 75th percentile in both winter and spring on the LSF measures. For both the March and May network maps, letter sound instruction was present (14% of 28 minutes of total reading instruction time for March and 19% of 25 minutes for May; see Figures 1a and 1c), suggesting that this topic may have been a regular part of their instructional routine toward the second half of the year. Because student performance by winter was already strong, our network maps provide little evidence of substantial gains, but instead show that the high levels of fluency were maintained, on average, for the class.

Across both time points, students PSF scores were around the norm 50th percentile (32 pscpm in winter and 44 pscpm in spring). Phoneme segmenting practice was consistently observed for all three observations (14% of instruction time in March, 8% in April, and 7% in May) in which students counted the number of phonemes in words, segmented them (using their fingers as a physical prompt), as well as substituted and blended phonemes to make new words. Although six students fell below the class mean (S13, S14, S16, S17, S18, and S20), the fairly consistent segmenting practice over time may have allowed the rest of the class to maintain average skills.

On the WRF measures, the average gain score from winter to spring for the class was 9.9 wcpm, which fell at the 50th percentile. On this measure, two students (S3 and S7) had scores much higher than the class (in winter and spring, respectively), and therefore, their data could skew the average gain score. When these outlier scores were removed, the average gain score dropped slightly to 9.5 wcpm, the average winter score dropped from 3.7 to 2.3 (slightly below the 50th percentile score), and the average spring score dropped from 14 to 12 (still above the 50th percentile score).

Unlike LSF, in which students began winter with knowledge of at least 10 sounds, winter WRF performance reflected less familiarity with words (except for S3 and S7), although six students total were able to produce at least five words per minute. Based on the patterns found in the network analysis, two types of word reading activities were regularly observed: *high frequency word recognition* and *word decoding*. Similar to letter sound practice, these word identification activities reflected mostly isolated “drill” practice using charts and not text (average of 9% of instruction time). Scores for the majority of students indicated moderate gains during the four-month period.

Limitations

The network maps from this study are not generalizable to other kindergarten general education classrooms for several reasons. First, data collected from this study originated from a case study of a single half-day kindergarten teacher in a Pacific Northwest elementary school. The students in this classroom may not be similar to students in other settings. Second, due to logistical constraints, the network maps were created using only a subset of the original observational data that spanned from January to May 2012. Because only three sets of observations (specifically for Week 1, Day 3 of each curricular unit) were coded for analysis here, the findings reflect the reading skills for only three months toward the end of the academic school year. This constraint also subsequently limited the number of words for each analysis, which explains the low density values in the networks.

Discussion

In this study, we used network text analysis to identify key beginning reading concepts that underlie spring kindergarten general education literacy instruction. Our analysis was comprised of one structural network map per observational time period and revealed instructional approaches mainly related to text-and word-based activities, as evidenced by the large node size and centrality of their placement in the instructional skill networks. Based on our maps, a substantial proportion of reading concepts were related to text- and word-based activities. From the main network, smaller regions of concepts related to letter sounds, phonemes, and concepts of print activities emerged.

Although these inter-related concepts were present across the three time points, the instructional network maps changed over time. The text-based activities tended to reflect comprehension strategies consistently, such as using picture clues, inferring, identifying the sequence of events, explaining words (i.e., *vocabulary*) to support meaning-making, and noting details. Other reading strategies such as monitoring/clarifying student understanding and main idea of the story occurred twice. The least occurring reading skills included characters, building background, drawing conclusion, and distinguishing realism and fantasy. The print concept knowledge over the months diversified from a focus on just punctuation in March to also include instruction in capital letters, and text directionality in April, and story setting and author identification in May. Although the teacher was fairly consistent with her *COP* instructional targets as they related to punctuation over time, none of the other concepts of print activities emphasized for any month corresponded well with the curriculum objectives for that day of instruction. Inspection of our observation notes suggested that the teacher taught these elements on a “need to know” basis, introducing elements of punctuation, for example, as appropriate for the text being read.

The code-focused activities also reflected some consistency, but also some changes. Phoneme awareness related skills were consistently taught across the months, reflected in the regular representation of substitute, blend, and segment with phonemes. However, there were other aspects of phoneme awareness skills that were not consistently enacted across all three observations. For example, in March phoneme activities included counting and segmenting, which were indirectly related to the word node because they both entailed multiple opportunities for practice. However, in April and May, phoneme activities included segmenting, substitution, and (for April only) blending, tasks that did not involve multiple opportunities for practice. This change in task structure eliminated the prior relation to the word node. In addition, activities to strengthen high frequency word recognition were present in all three observations. Both March and April maps indicated word decoding activities, as well. By May, these activities were replaced by spelling instruction, reflecting a shift in sophistication for word knowledge instruction.

Overall, we found moderate consistency of general concepts in early reading instruction across the three time points (47-53%) in 30-minute whole-class reading instruction periods, with some diversification of specific reading skills. We also found that the average winter-spring growth of the students in the classroom was 10 wcpm on the WRF measures, 16 lscpm on the LSF measures, and 17 pscpm on the PSF measures. Although we found that the reading concepts did not always overlap with the curriculum target skills, the consistency of teaching practice we did observe could be one of the factors to explain the measured reading-related performance gains found (Al Otaiba et al., 2008), which warrants further empirical and controlled studies. From the observed 20-30 minutes of instructional time, 60-70% of the total time was consistently used for text-based activities, 8-12 % on code-focused activities (across April and May), 14-20% (March and May) on letter sounds activities, and 8-14% on phoneme-related activities.

The network maps from this study were able to: (a) capture the underlying structure of beginning reading instruction, (b) highlight the variety of skills across the spectrum of “code-focused” and “meaningful” text-based activities that were covered from March to May, (c) illustrate how each of the reading concepts was interconnected with the others, and (d) visually capture change of instructional activities over time. Future studies should include the analysis of complete observations to strengthen the validity and generalizability of the network structural maps. Although our study was small and thus limited in terms of the generalizability of our findings, it does illustrate that network analysis can be a useful tool to use in qualitative and case study approaches to studying reading instruction.

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Table 1
Published Curriculum Target Beginning Reading Skills

Month	**Skills**					
	Comprehension Strategy	**Comprehension Skill**	**Phonemic Awareness**	**Phonics**	**Concepts of Print (COP)**	**High Frequency (HF) Words**
March	Summarize	Text Organization and Summarizing	Blending and segmenting phonemes	Beginning sound /d/; initial consonant D,d; short vowel /i/	First/Last Letter in a Word; Matching Words	for, see, and, to, go
April	Evaluate	Sequence of Events	Syllables in spoken words; phoneme substitution (final)	Review Consonant w; Blending Short e Words	Letters, Words, and Sentences; First and Last Letter in a Written Word	play, said, a, my
May	Question	Story Structure: Beginning, middle, end	Phoneme substitution (initial and final)	Beginning sounds /j/; initial consonant J, j; short vowel /u/	Capital at the Beginning of a Sentence	are, said, the, play, she

Table 2
Descriptive Information for March, April, and May Network Maps

Network Measures	March	April	May
RC count	23	26	23
Link count	42	26	22
Density	0.08	0.04	0.04
Total Number Words in Text	190	162	299
% Overlap with March	-	53.11	48.67
% Overlap with April	-	-	46.85

Note. Frequency = the sum of the reading skill's frequency attribute in the network; hf = high frequency; RC count = the number of reading concept in a unimodal network; Link count = the number of links or ties in the network; Density = the ratio of the number of links versus the maximum possible links for a network.

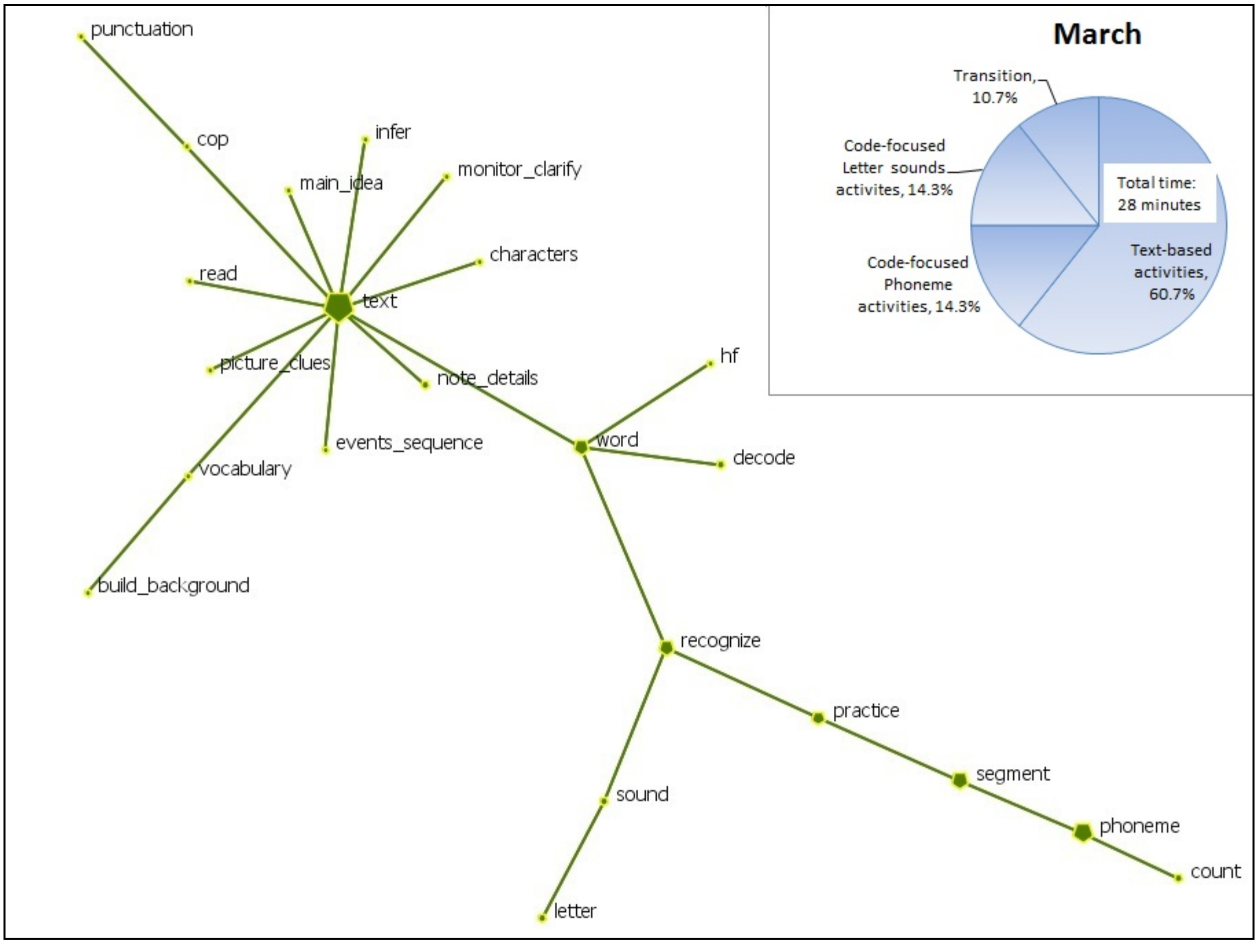

Figure 1a. March network map and time spent on reading activities.

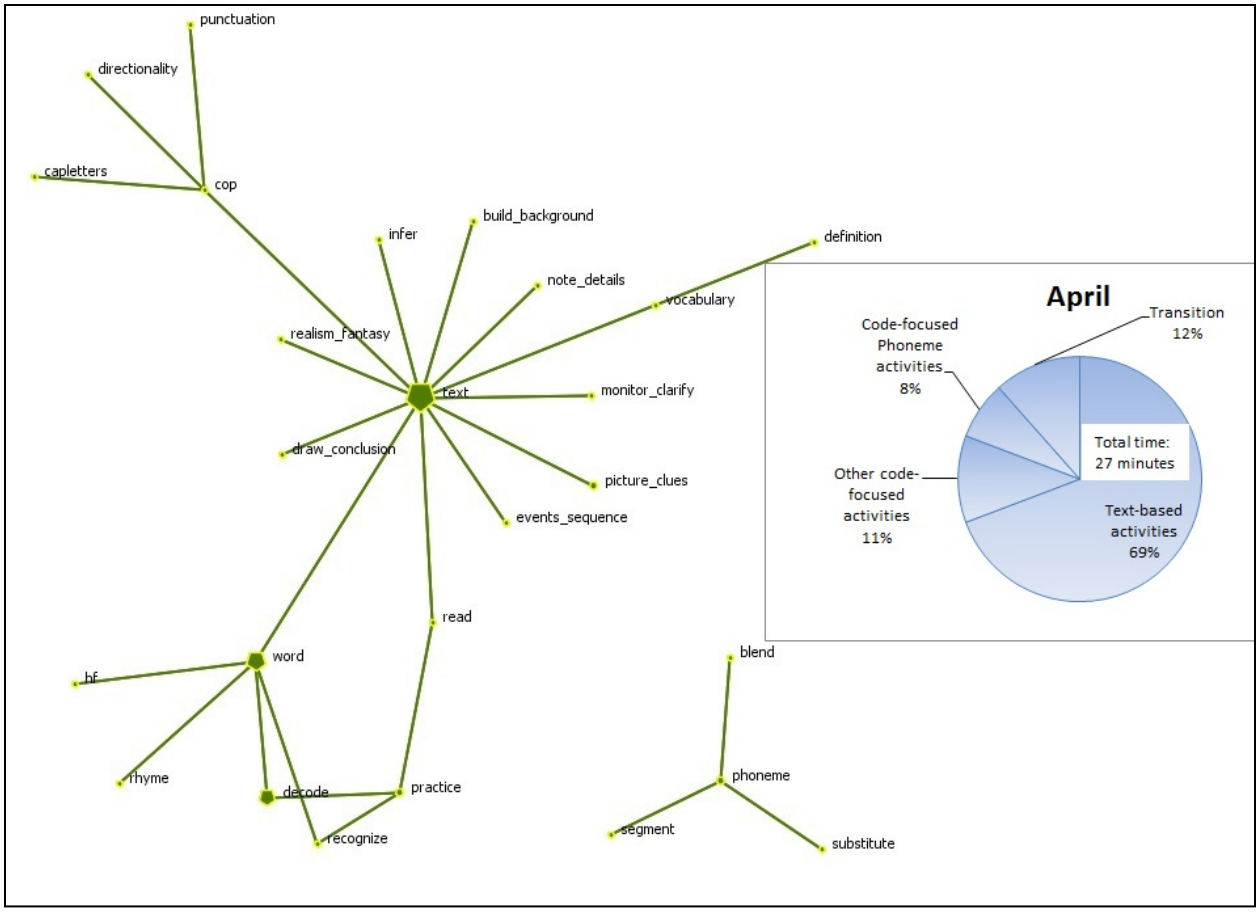

Figure 1b. April network map and time spent on reading activities.

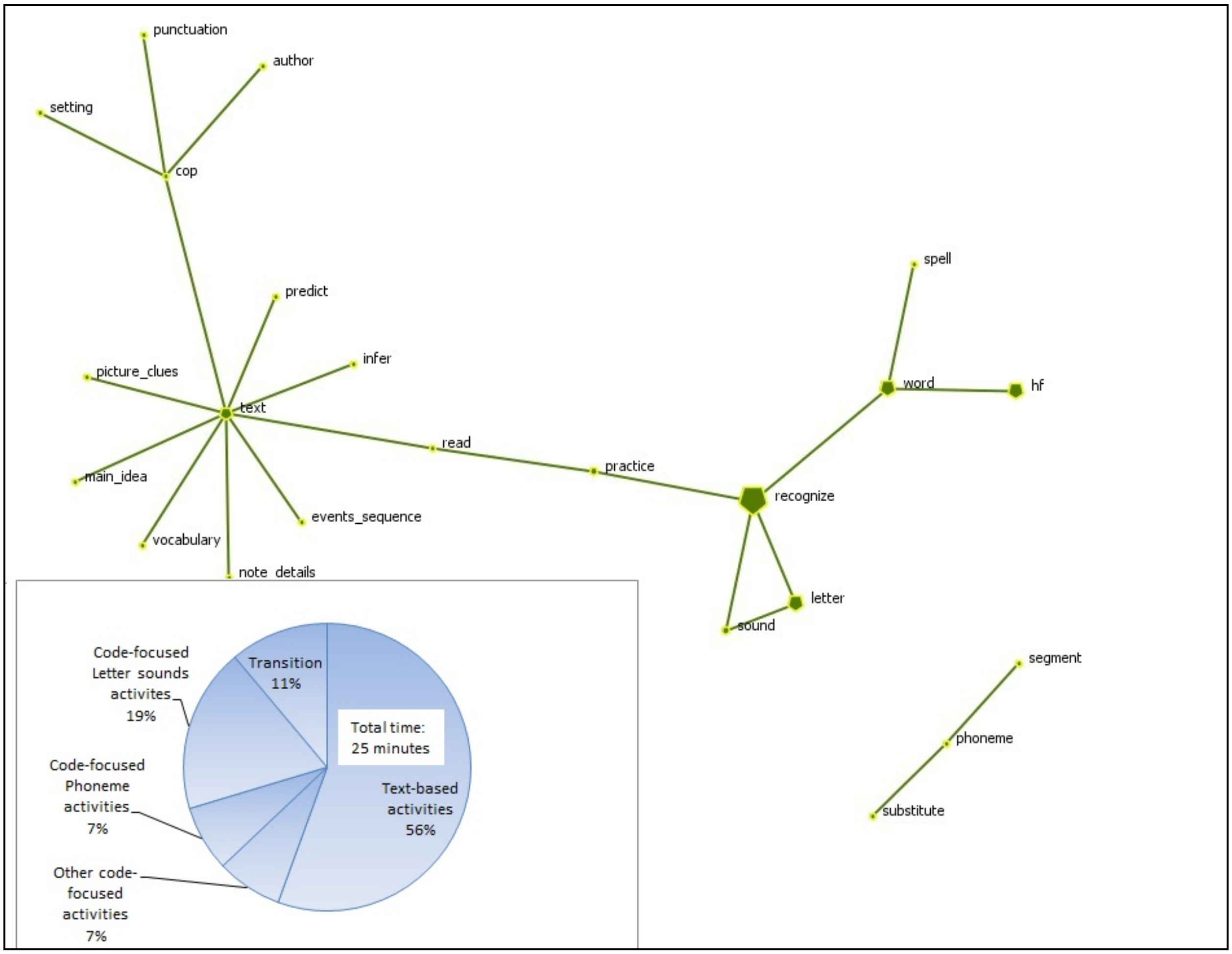

Figure 1c. May network map and time spent on reading activities.

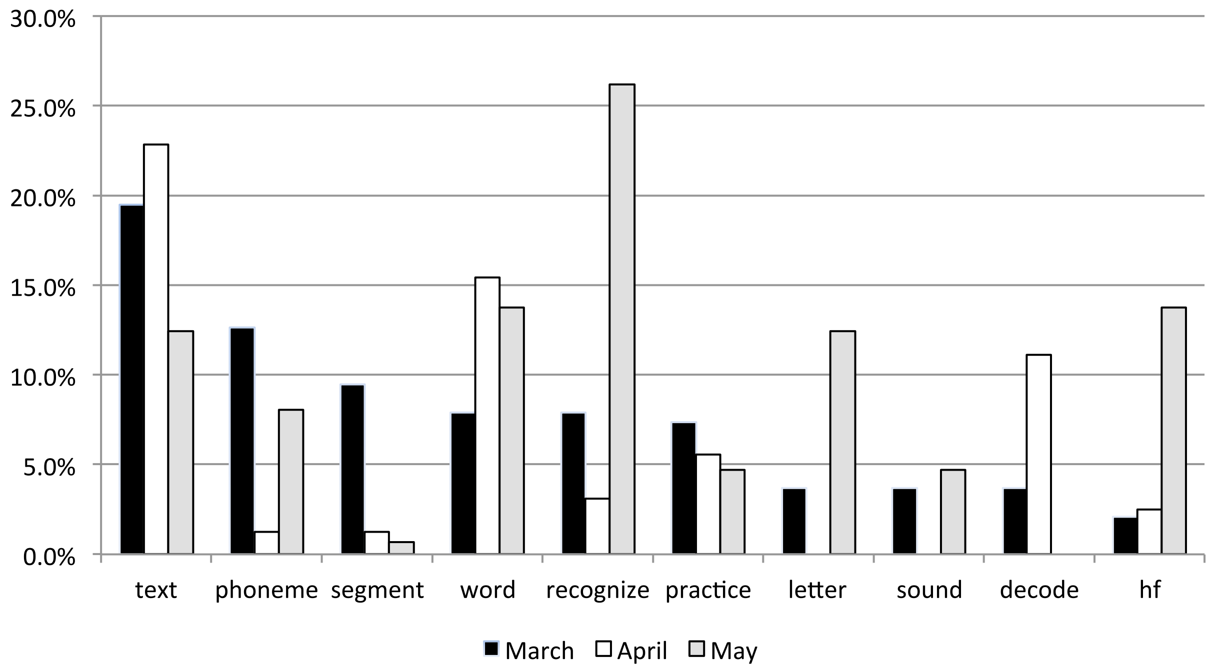

Figure 2. Percentage of reading concepts for each month.

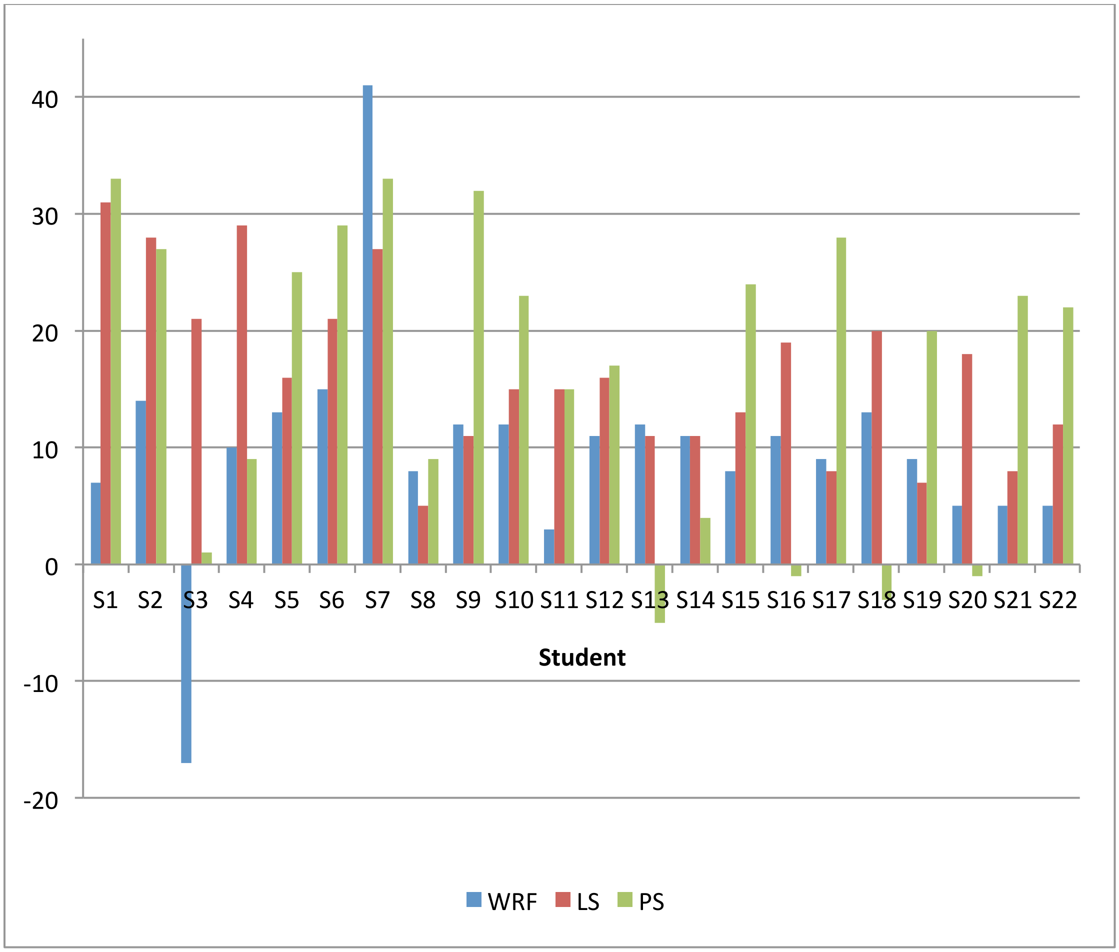

Figure 3a. Gain scores for winter and spring for each student on all three easyCBM measures.

Figure 3b. Student scores on Letter Sounds Fluency measures for winter and spring.

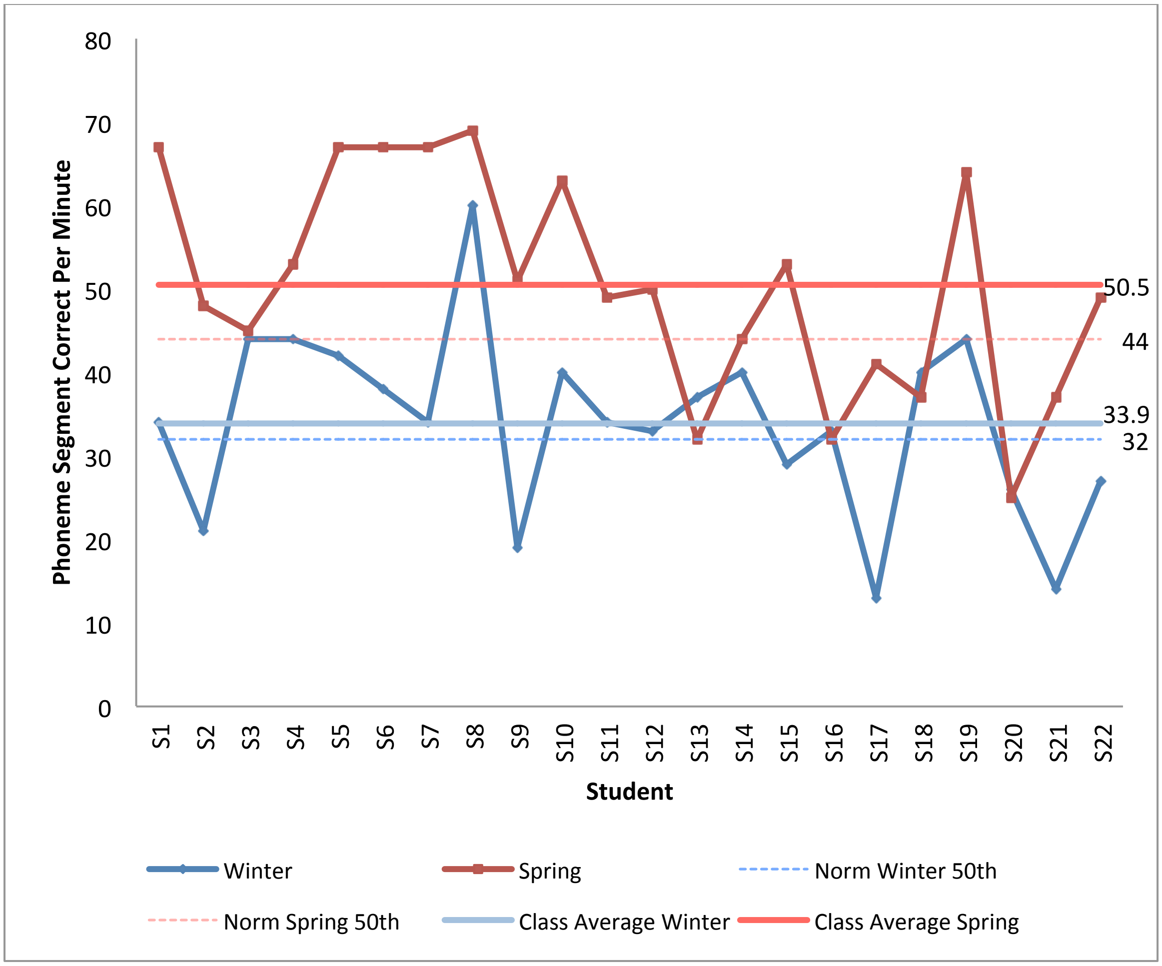

Figure 3c. Student scores on Phoneme Segmenting Fluency measures for winter and spring.

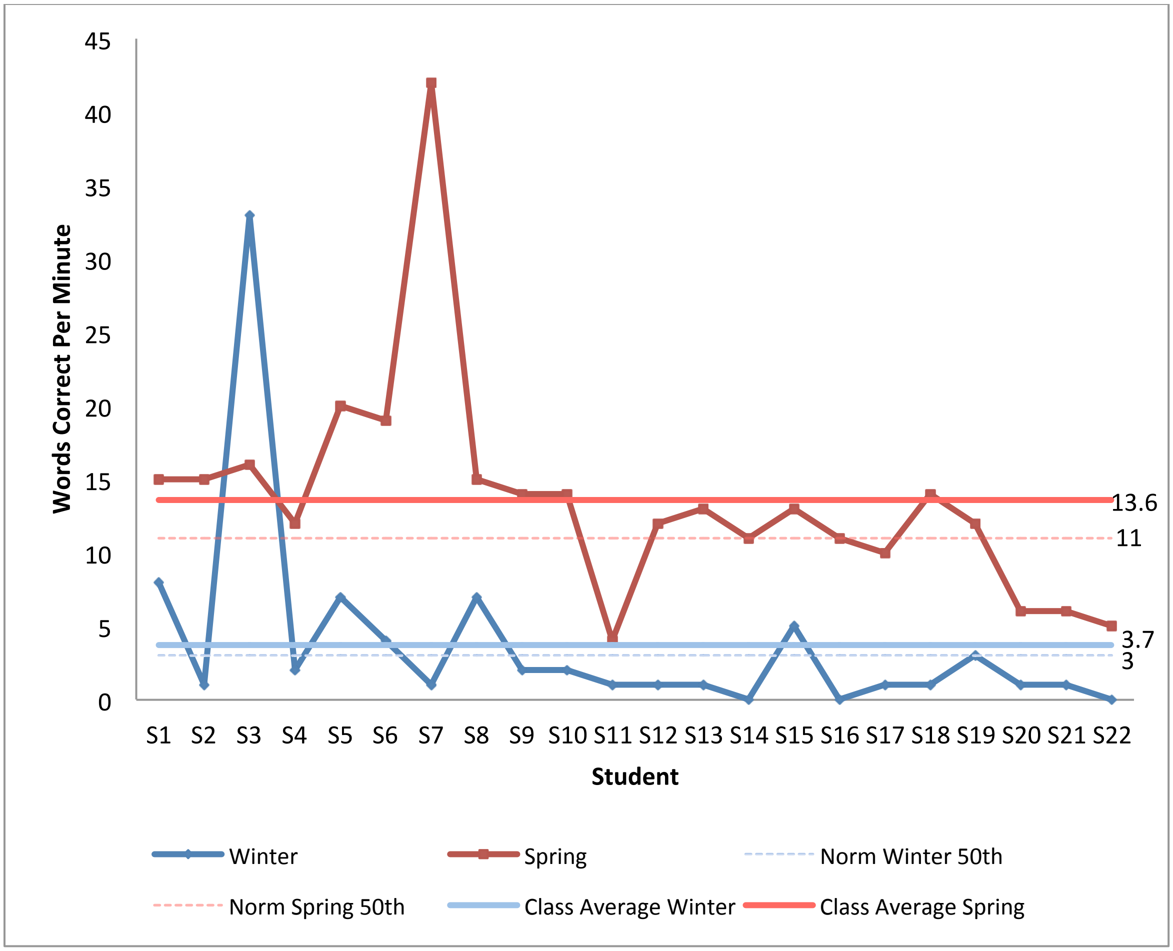

Figure 3d. Student scores on Word Reading Fluency measures for winter and spring.

Appendix
Code Dictionary

Beginning Reading Skills	Meaning
definition	Define
hf word	High Frequency word
letter Sounds	Letter sounds practice
phoneme blend	Phoneme blending
phoneme count	Phoneme counting
phoneme segment	Phoneme segmenting
phoneme substitute	Phoneme substituting
practice	Repeated practice opportunity
recognize	Word identification related to orthography, not phonics ("sounding out")
spell	Spell
strategy	Use of a strategy to aid comprehension
text building_ background	Building background knowledge pertaining to a text
text characters	Learning about characters in story
text cop author	Concepts of Print (Author) pertaining to a specific text
text cop capletter	Concepts of Print (Capital Letters) pertaining to a specific text
text cop Directionality	Concepts of Print (Directionality) pertaining to a specific text
text cop punctuation	Concepts of Print (Punctuation) pertaining to a specific text
text cop setting	Concepts of Print (Setting) pertaining to a specific text
text draw_conclusion	Drawing conclusions using a text
text event_ sequence	Sequence of events pertaining to a text
text infer	Making an inference pertaining to a text
text main_idea	Main idea pertaining to a text
text monitor_clarify	Monitoring or clarifying text

text note_details	Noting details about what's happening within a text
text picture_clues	Using picture clues to extract meaning about a text
text predict	Getting students to anticipate what happens next
text read	Text reading (sentence/paragraph)
text realism_fantasy	Using the text to distinguish between real and fantasy stories
text recall	Recalling details from text
text vocabulary	Learning new vocabulary pertaining to a text
text word recognition	Recognition of words in text
word decode	Word decoding
word rhyme	Rhyming