The Role of Discourse Knowledge in Writing among First-graders

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Abstract: Theoretical models of early writing support the importance of discourse knowledge to writing (Bereiter & Scardamalia, 1987; Berninger & Winn, 2006). However, there is limited research on the relationship between discourse knowledge and writing among beginning writers. This study explored whether fall, spring, and change in discourse knowledge predicted first-graders' end-of-year writing. Three hundred eighty first-graders were given a discourse knowledge interview in the fall and spring assessing knowledge of writing production procedures, substantive processes, story elements, and writing motivation. Additional fall assessments included handwriting fluency, spelling, reading, and vocabulary. Students' narrative and descriptive writing was assessed at the end of the year. Hierarchical linear modeling showed that fall discourse knowledge and knowledge gain variables were not consistent predictors for writing outcomes. However, a more consistent relation was found between spring discourse knowledge and writing achievement, where production procedures predicted writing in both genres while substantive processes and story elements only predicted narrative writing. This study extended findings from earlier research by examining the discourse knowledge and writing achievement of young students.

Keywords: Descriptive writing, discourse knowledge, first grade, narrative writing

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Writing well has become an essential requirement for students in the U.S. (CCSS, National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010; Graham & Harris, 2015; Graham & Perin, 2007). However, the results from the National Assessment of Educational Progress (NAEP) writing subtest showed that fewer than 25% of 4th-grade students performed at or above the proficient level in writing (Salahu-Din, Persky, & Miller, 2008).

Students' writing difficulty can be partly attributed to the complex nature of writing. In both a recent and an earlier review of writing research, Bazerman et al. (2017) and Graham (2006) noted the range of cognitive and sociocultural factors that contribute to writing development. Besides strategies, skills, motivation, self-efficacy, contextual factors and demographic factors, knowledge about topic, intended audience, and genre play instrumental roles in writing achievement. Despite the importance of knowledge, writing research has focused on the impact of writing processes on achievement (Fidalgo, Torrance, & Garcia, 2008; Fitzgerald & Teasley, 1986; Graham, McKeown, Kiuhara, & Harris, 2012; Torrance, Fidalgo & Garcia, 2007), and the role of writing knowledge has been under-studied (Graham, Wijekumar, Harris, Lei, Fishman, Ray, & Houston, 2019). This study was designed to expand the empirical work on discourse knowledge in the writing achievement of young writers.

Discourse knowledge encompasses several types of knowledge. McCutchen (1986) refers to discourse knowledge as "schemata for various discourse forms, procedures and strategies involved in the instantiation of those schemata, as well as local sentence-generation procedures that draw on grammatical knowledge" (p. 432). This widely cited definition signals that discourse knowledge includes metacognitive knowledge (knowledge of the characteristics of good writing in general, and knowledge of writing processes) and genre knowledge (i.e., knowledge of the attributes of different text structures).

Metacognitive knowledge reflects writers' beliefs about writing and their cognitive processes in the act of writing. It taps writers' awareness of the purposes, processes of writing and the self-regulation of such processes and related thoughts, feelings, and actions (Lin, Monroe, & Troia, 2007). Three types of knowledge constitute metacognitive knowledge, including declarative knowledge of what constitutes good writing, procedural knowledge of writing processes, and conditional knowledge of strategies appropriate under different writing conditions.

Genre knowledge describes the attributes of different text structures (Olinghouse & Graham, 2009), and it reflects an understanding that text structure is specific to its text type (Hasan,1985). Genre knowledge is important because the explicit knowledge of rhetorical structures helps writers generate the macro-features of the targeted text type. It is likely that an understanding of these two types of knowledge (metacognitive knowledge and genre knowledge) is important for beginning writers, but there is little empirical support for this claim.

Discourse knowledge in this study is conceptualized following a series of studies by Olinghouse and colleagues (2009, 2013, 2015). This understanding of discourse knowledge is framed by McCutchen's (1986) definition that included metacognitive knowledge and genre knowledge. To be specific, discourse knowledge in this study is defined as including knowledge of the characteristics of good writing in general, knowledge of writing processes, and genre knowledge.

1.1 Discourse Knowledge in Writing during Elementary School Years

Our study was grounded in two specific cognitive models of early writing (Bereiter & Scardamalia, 1987; Berninger & Winn, 2006). Bereiter and Scardamalia's (1987) knowledge-telling model describes how young, developing writers retrieved topic and discourse knowledge to represent that information when they wrote. This process is referred to as knowledge-telling. However, skilled writers transform knowledge during writing as they strategically retrieve and synthesize information about the topic. Both knowledge-telling and knowledge-transforming processes leverage content and discourse knowledge to generate ideas and compose genre-specific texts (Benton, Corkill, Sharp, Downey, & Khramtsova, 1995; McCutchen, 2000; Olinghouse, Graham, & Gillespie, 2015).

Berninger and Winn's (2006) Not-So-Simple-View of Writing identifies key factors that contribute to young writers' development. These include transcription (i.e., handwriting, spelling, keyboarding), executive functions (i.e., conscious attention and self-regulation strategies for different writing processes), and text generation (i.e., background knowledge, including language and discourse features) as fundamental components operating in a working memory environment. The model also depicts potential sources of individual differences for early writing development, including components of discourse knowledge. Young writers need to activate and use knowledge about the topic and genre stored in long-term memory (McCutchen, 2006) when generating written language.

Although they differ in many respects, both theoretical models position the components of discourse knowledge as important predictors of writing achievement. For our study, both models are useful for different reasons. The knowledge-telling model provides an explanation for how young writers represent discourse knowledge in their writing, and the Not-So-Simple-View of Writing provides a framework to understand how discourse knowledge interacts with cognitive skills such as transcription and memory capacity.

Across studies with upper elementary students, researchers have found a positive relationship between discourse knowledge and writing quality (Englert, Raphael, Fear, & Anderson, 1988; Olinghouse et al., 2015; Olinghouse & Graham, 2009; Saddler & Graham, 2007). For example, Englert et al. (1988) reported positive relationships between fourth- and fifth-grade students' knowledge of writing processes and expository writing. Saddler and Graham (2007) investigated the question of whether students' individual differences in metacognitive knowledge

about writing were related to differences in writing performance. More skilled fourth-grade writers knew more about the substantive aspects of writing and used more substantive procedures during composing than less-skilled writers. For the more-skilled writers, their metacognitive knowledge was related to the length and quality of their narratives. The authors suggested that the writing knowledge of less-skilled writers was not well integrated, limiting its application during writing.

Olinghouse and colleagues (2009, 2013) identified two major aspects of discourse knowledge: knowledge of substantive processes, related to composing (i.e., writing processes, idea generation and development, and text structure) and knowledge of production procedures, related to mechanics (i.e., handwriting, spelling, and conventions of English). In grades two and four, the compositional aspects of discourse knowledge predicted students' vocabulary and genre knowledge, and the mechanical aspect of discourse knowledge predicted narrative quality (Olinghouse & Graham, 2009).

Previous studies demonstrated a relationship between topic knowledge and text quality (Benton et al., 1995; McCutchen, 1986; Monsenthall, Conley, Colella, & Davidson-Mosenthall, 1985; Voss, Vesonder, & Spilich, 1980), text length (Chesky & Hiebert, 1987), and text coherence and elaboration (Benton et al., 1995; McCutchen, 1986). When including measures of topic knowledge in these studies, components of discourse knowledge were found to explain more variance in writing than topic knowledge for students in upper elementary and middle grades (McCutchen, 1986; Olinghouse et al., 2015). However, in a recent study by Graham et al. (2019) with fifth graders, writing knowledge did not predict persuasive writing quality; however, topic knowledge did. One explanation for this finding is that writing knowledge may not be well aligned with the writing tasks because the researchers assessed writing knowledge with a task that asked students to supply missing words from an informational text. This cloze task may have also tapped students' knowledge of syntax and the logical connections among ideas instead of solely eliciting writing knowledge. Given that the measure for assessing knowledge differed from that used in the previous studies, the finding from this study needs to be interpreted with caution.

Further evidence of the importance of forms of discourse knowledge to writing comes from intervention studies (Fidalgo et al., 2008; Fitzgerald & Teasley, 1986; Gambrell & Chasen, 1991; Graham & Harris, 2005; Graham, McKeown, Kiuhara, & Harris, 2012; McCutchen, Francis, & Kerr, 1997; Mosenthall, Conley, Colella, & Davidson-Mosenthall, 1985; Torrance, Fidalgo, & Garcia, 2007; Wong, Butler, Ficzere, & Kuperis, 1996). Instruction in narrative structure improved the organization and quality of fourth-grade students' essays (Fitzgerald & Teasley, 1986), and instruction in genre knowledge, strategy knowledge and knowledge of writing processes also strengthened students' writing (Gambrell & Chasen, 1991; McCutchen et al., 1997; Wong et al., 1996). In a series of strategy-focused interventions, large effects on both text quality and students' adoption of writing strategies were found for students in

sixth and eighth grades (Fidalgo et al., 2008; Torrance et al., 2007). In these strategy-focused studies, forms of discourse knowledge were just one component of the interventions. Therefore, it is possible that students' improvements could be attributed to other components of the strategy-based interventions.

1.2 Limitations in the Research

There are some notable limitations of the studies on discourse knowledge. First, few include students from the early elementary grades. One of the only studies to investigate the relationship between discourse knowledge and writing achievement with young students included students in second and fourth grades (Olinghouse & Graham, 2009); however, there were not separate analyses for each grade level, which made it difficult to assess the strength of the relationship for second graders.

Several intervention studies with Self-Regulated Strategy Development (SRSD) included primary grade students (Graham, Harris, & Mason, 2005; Harris, Graham, & Mason, 2006; Zumbrunn & Bruning, 2013). SRSD includes multiple aspects of discourse knowledge (i.e., genre knowledge and writing process knowledge), and SRSD improved students' writing knowledge and performance. However, the multiple-component nature of SRSD made it impossible to isolate the effect of discourse knowledge on writing achievement.

Secondly, it is unknown whether growth in discourse knowledge predicts the quality of students' writing. Cross-sectional studies revealed children's gradual approximation of more advanced genre features over time (Donovan, 2001; Kamberelis,1999) and increased metacognitive and writing-process knowledge with age and schooling (Kos & Maslowski, 2001; Lin, et al., 2007). These results signaled that dimensions of students' discourse knowledge (i.e., genre knowledge and knowledge about good writing in general) develop over time. While it seems likely that growth in forms of discourse knowledge would strengthen students' writing, we were unable to locate studies that investigated this question with young writers. This study was designed to expand the empirical work on whether and how discourse knowledge predicts the writing achievement of beginning writers.

1.3 Additional Predictors of Writing for Young Children

As discussed previously, a complex set of skills and knowledge sources contribute to successful writing. In order to investigate specific components of discourse knowledge, it is important to account for additional writing predictors. For example, handwriting, spelling, and vocabulary are prominent in the Not-So Simple-View of Writing (Berninger & Winn, 2006), and they have accounted for substantial variance in both writing quality and length (Coker, Jennings, Farley-Ripple, & MacArthur, 2018; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997; Graham & Harris, 2015; Graham, Harris, Chorzempa, 2002; Kim, AL Otaiba, Puranik, Folsom, Greulich, & Wagner, 2011; Kim & Schatschneider, 2017; Wagner, Puranik, Foorman, Foster,

Wilson, & Tschinkel, 2011). Decoding has also demonstrated a strong relationship with writing (Shanahan, 1984, 2006; Fitzgerald & Shanahan, 2000). Additionally, both age and gender have also been associated with writing achievement. Older children had better transcriptional skills, wrote longer and produced better quality written texts than their younger peers (McCutchen, 2006), and girls have demonstrated better transcriptional skills (Berninger & Fuller, 1992), more positive attitude towards writing (Knudson, 1992; Pajares &Valiante, 1999) and better writing quality (Kim, AI Otaiba, Wanzek, & Gatlin, 2015; National Center for Educational Statistics, 2012) than boys.

1.4 Current Study

Given the importance of early writing development for later success (Graham, Bollinger, Booth Olson, D'Aoust, McArthur, McCutchen, & Olinghouse, 2012; McCutchen, 2006), more focused research on the relationship between writing-related knowledge and early writing performance is needed. Specifically, the study investigated the following question: What is the relationship between first-grade students' discourse knowledge and narrative and descriptive writing performance after controlling for writing-related factors (vocabulary, reading skills, transcription skills, age and gender)? Three sub-questions included:

1. Does first-grade students' fall discourse knowledge predict end-of-year writing performance?
2. Does first-grade students' spring discourse knowledge predict end-of-year writing performance?
3. Does change in first-grade students' discourse knowledge across a school year predict end-of-year writing performance?

Based on the empirical findings about discourse knowledge for upper-elementary-grade students and the extensive literature on the important correlates of writing (i.e., decoding, transcriptional skills, oral vocabulary etc.), the following two hypotheses of the study were made: 1) First-graders were hypothesized to have emerging discourse knowledge with greater surface-level mechanical knowledge than substantive compositional knowledge, and that discourse knowledge would increase from fall to spring. 2) Fall, spring, and growth in discourse knowledge were hypothesized to predict the quality and length of narrative and descriptive writing in first grade.

2. Method

2.1 Background of the Study

The study was embedded into a larger study designed to identify instructional practices related to students' writing achievement (Coker, Farley-Ripple, Jackson, Wen, MacArthur, & Jennings, 2016). Data collection for the larger study was completed in two years (from 2012-2014). Across the 50 classrooms where students were sampled, information about writing instruction was obtained through classroom observation. There was considerable variation in the writing curriculum across classrooms. The most commonly used writing curriculum was integrated with the reading curriculum (*n*= 22), and the second most common was a non-fiction writing program (*n*= 5). Many teachers reported using no standard curriculum (*n*=23). Teachers were observed using a writer's workshop approach to writing instruction and allocating an average of 26.4 minutes per day on writing instruction (Coker et al., 2016).

2.2 Participants

Participants in this study included 380 first-grade students from 50 classrooms in 13 schools in three school districts in a Mid-Atlantic state. The districts are demographically diverse, medium-size districts (ranging from about 10,000 to 17,000 students) in urban and suburban neighborhoods. The participating schools serve a diverse range of students in terms of ethnicity, language status, and socioeconomic status (SES). Student demographic information is reported in Table 1. For this study, students' average age was 6.5 years old (SD = 4.38 month). 52.1% were female students and 47.9% were male students. The sample included 28.4% African American students, 47.9% Caucasians, 12.2% Hispanics and 8.2% Others (including Asian, Multiracial, Native American, Native Hawaiian).

Table 1. Demographic Information for Participants (N= 380)

	M(SD)	Range
Age	78 (4.4)	66-94
Race		
African American	28.4%	
Caucasian	47.9%	
Hispanic	12.2%	
Other	8.2%	
Gender		
Male	47.9%	
Female	52.1%	

Note. Other includes Asian, Multiracial, Native American, and Native Hawaiian.

2.3 Measures

A battery of assessments was given to students that assessed composing, transcription, vocabulary, and reading skills. Two writing assessments were administered at the end of the school year. To assess students' discourse knowledge, two interviews were conducted in both the fall and spring. The following section details the administration and scoring procedures.

2.4 Writing outcomes

2.4.1 Composing tasks

A narrative and a descriptive writing prompt were administered to students in the spring in a group setting of three to four students. The narrative prompt was "Think about one of your favorite activities. Write a story about a time that you had fun doing this activity." The descriptive prompt was "Think about a person you know well. It could be someone in your family or a friend. Describe that person and tell what he or she is like to someone who doesn't know him or her." Students were given 20 minutes to complete each writing task. To reduce the confounding factor of topic knowledge in the writing process, the prompts were designed to have topics familiar to students. To reduce the potential confounds with reading skill, the prompts were read to students. At least a day was given in between these two prompts to reduce the fatigue effect among students.

The narrative and descriptive texts were scored for length and quality. The length score was calculated by using the word count feature in a spreadsheet. Before scoring for quality, students' texts were typed, and spelling, punctuation, and capitalization errors were corrected. The texts were typed and corrected to reduce potential bias due to poor handwriting and spelling (Troia, Graham, & Harris, 1999). To score the quality of both prompts, a traditional, 6-point holistic rubric was developed, with six representing the highest score. The quality rubric focused on three dimensions: topic and detail; organization and supporting details; and word choice (see Appendix A). A holistic score was given to each written text according to the rubric. When scoring, two raters were trained with practice samples. Once they reached a threshold of 90% inter-scorer agreement, one of the raters scored the total sample, and 20% of the sample was double-scored. The inter-scorer agreement was 96.2% for narrative quality within one point, and 96.8% for descriptive quality within one point. The inter-scorer agreement between two scores for both narrative quality and descriptive quality was high ($r = .87$).

2.4.2 Writing control assessments

Handwriting fluency has been used in many research studies with primary-grade students (Coker, Ritchey, Uribe-Zarain, & Jennings, 2017; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997; Hudson, Lane, & Mercer, 2005; Jones &

Christensen, 1999; Puranik, Patchan, Sear, & McMaster, 2017; Wagner et al., 2011). In this individually-administered assessment, students were given a piece of lined paper and a pencil without an eraser. Then the examiner asked students to write 26 lower-case alphabetic letters in one minute. Students were informed that every 15 seconds the examiner would mark a slash on the lined paper to indicate students' progress. The total number of correct written letters in the first 15 seconds was counted for analysis since first-grade students may not be able to write all the 26 letters at the beginning of the fall.

One point was awarded for each correctly formed letter in alphabetical order. Letters that were illegible, incorrectly formed, or out of alphabetic order were scored as 0. The inter-scorer agreement for handwriting fluency test was 100%.

Spelling ability was measured by the norm-referenced Spelling subtest from WJ-III Test of Achievement (Woodcock, McGrew, & Mather, 2001). The test measures students' spelling skills using words of increasing difficulty. Test developers reported a split-half reliability of .92 for six-year-olds and .91 for seven-year-olds. The criterion validity coefficient between WJ-III Basic Writing Skills (i.e., Spelling) and the Kaufman Test of Educational Achievement (KTEA; Kaufman & Kaufman, 1985) Spelling was .77 (McGrew & Woodcock, 2001). In small groups, students were given a piece of lined paper and asked to write the targeted letters or words dictated by the examiner as specified in the WJ-III manual.

The scoring process followed the procedures in the test manual. The WJ-III Spelling subtest was double scored with 100% inter-scorer agreement.

2.4.3 Vocabulary control assessments

Students' receptive vocabulary ability was measured individually with the Peabody Picture Vocabulary Test-Fourth Edition (PPVT-4, Dunn & Dunn, 2007), which is a norm-referenced assessment of vocabulary breadth. The PPVT-4 manual reported an internal consistency of .95 and .97 for six- and seven-year-olds respectively. The test-retest reliability for five- and six-year-olds and for seven-ten-year-olds was .84 and .91 respectively (Dunn & Dunn, 2007).

Scoring followed the process described in the test manual. The raw score is the total number of corrected answered words. All students' responses were double scored by two raters, and the inter-scorer agreement was 99.6%.

Productive language ability was measured by the Expressive One-Word Picture Vocabulary Test- Fourth Edition (EOWPVT-4, Martin & Brownell, 2011) individually. The Cronbach's coefficient alpha for its internal consistency reached .97 and .95 for six- and seven-year-olds (Martin & Brownell, 2011).

Students' responses were scored according to the manual. The raw score is the total number of correctly answered items. All students' responses were double scored and the inter-scorer agreement between two scorers was 98.3%.

2.4.4 Reading control assessments

To assess first graders' reading skills, two reading tests, the WJ-III Letter Word Identification (WJ-III LWID) and Word Attack Subtests (WJ-III WA), were used to measure students' decoding and word recognition skills (McGrew, Schrank, & Woodcock, 2007).

The WJ-III Letter Word Identification subtest (LWID) assessed students' decoding skills by asking students to identify individual letters and to read words in isolation. The test had a split-half reliability of .98 and .97 for six- and seven-year-olds and reported a correlation coefficient of .75 with WJ-III Word Attack subtest (McGrew et al., 2007). The criterion validity coefficient between WJ-III Basic Reading (i.e., Letter-Word Identification and Word Attack) and the Kaufman Test of Educational Achievement (KTEA; Kaufman & Kaufman, 1985) Reading Decoding was .66 (McGrew & Woodcock, 2001).

Student responses were scored according to the manual. The inter-scorer agreement between two raters for WJ-III Letter Word Identification test was 100%.

The WJ-III Word Attack subtest (WA) was used to measure students' decoding skills. Students were asked to read pseudo-words aloud. The split-half reliability for Word Attack for six- and seven-year-olds was .94 and .92 (McGrew et al., 2007). The criterion validity coefficient between WJ-III Basic Reading (i.e., Letter-Word Identification and Word Attack) and the Kaufman Test of Educational Achievement (KTEA; Kaufman & Kaufman, 1985) Reading Composite was .76 (McGrew & Woodcock, 2001). The examiner provided lists of pseudo-words for students to read aloud and recorded students' responses. Both WJ-III subtests were administered individually.

Students' responses were scored according to the manual. The inter-scorer agreement for scoring WJ-III Word Attack between the two scorers was 100%.

Trained research assistants (RAs) administered all of the assessments. Testing occurred during school hours outside of the classroom in a quiet location. The standardized assessments included discontinuation rules or the use of basal and ceiling sets to minimize student fatigue (i.e., WJ-III Spelling, WJ-III LWID, WJ-III WA, EOWPVT-4, and PPVT-4).

2.4.5 Discourse knowledge interview.

In this study, discourse knowledge was measured by interview questions developed by Graham, Schwartz and MacArthur (1993) and refined by Olinghouse and colleagues (2009, 2013, 2015). Because of the use of an interview, discourse knowledge in this study refers to the type of knowledge that is readily available and can be explicitly discussed by students. When assessing discourse knowledge in young students, one challenge is that they may not be able to fully articulate what they know due to their developing meta-language or lack of vocabulary about discourse knowledge. Researchers have responded to this challenge by measuring

discourse knowledge in multiple ways. The measures used in past studies include either inferring students' discourse knowledge by examining students' written texts or by asking them about what they know about how to write (Gillespie, Olinghouse, & Graham, 2013; Graham et al., 1993; McCutchen, 1986; Olinghouse & Graham, 2009; Olinghouse, Graham, & Gillespie, 2015; Schoonen & de Glopper, 1996; Wray, 1993). While recognizing that an interview can be a limited measure of discourse knowledge for younger students, it is still an appropriate measure given that most children communicate better in oral language than writing (Wood, 1981; Vygotsky, 1978).

Six interview questions were asked to measure discourse knowledge (Graham et al., 1993; Olinghouse et al., 2009, 2013. 2015). The questions were designed to assess three major constructs of students' discourse knowledge. The first two (questions 1-2) assessed students' declarative knowledge about the characteristics of good writing. The next three (questions 3-5) asked about the procedural knowledge of writing and writing process. The last question (question 6) assessed students' knowledge of story grammar. Specifically, students were given a writing scenario and then asked to describe for a friend the elements and parts that should be included in a story. The question prompt read like this "*Suppose you have a friend who had to write a story for a class. If your friend asked you what kinds of things are included in a story, what would you tell him/her are the parts of a story?"* This question assessed students' knowledge about story structure (i.e., the beginning, middle and the end) and the key elements of a story (i.e., setting, character, plot, etc.). All questions were designed to be open-ended.

The interviews were conducted individually twice during the school year (fall and spring), and student responses were audio recorded. After each response, the interviewer prompted the student to elaborate by asking "Anything else?" until the student was clearly finished answering the question. If the student gave a vague or general response, clarifying questions such as, "How would you do that?" or "Can you tell me more?" were used. The entire interview took about three to nine minutes to complete.

Interviews were transcribed and then scored. The scoring system was adopted from previous work of Graham and colleagues (Gillespie et al., 2013; Graham et al., 1993; Olinghouse & Graham, 2009; Olinghouse et al., 2015).

Scoring entailed a four-step scoring process. In the first step, each transcribed response was divided into idea units defined as, "a specific, unit idea in a student's response" (Olinghouse & Graham, 2009, p. 40). Any repeated information was not considered as a new idea unit. Likewise, elaborations for an idea unit that did not provide unique information were not marked as a new idea unit. The second step was to categorize each idea unit according to its response type. The scoring categories were based on a system developed by Graham et al. (1993) and modified by Olinghouse and Graham (2009) that specified 14 response types: environmental structuring, substantive processes, production procedures, motivation, seeking

assistance, ability, other related, irrelevant, story elements, organization, clarity, vocabulary, creativity and ideation. For example, environmental structuring referred to students' efforts to select or arrange the physical environment to make learning easier (“Find a quiet room." "Get my materials ready."). Production procedures referred to mechanical aspects of writing or the written product (e.g., "Write neatly." "Spell the word correctly."). Substantive processes referred to writing processes, such as planning, drafting, and revising (e.g., "Keep a clear focus." " Use a story map to plan it.”). Story elements referred to statement about the story grammar such as setting, characters, plot, problem, and solution (e.g., "setting, plot and character"). Irrelevant applied to statements unrelated to the question (e.g., “Because I like it.” “It is on the computer.”). The third scoring step was to calculate the total number of idea units for each response type across questions. To reduce the potential of inflating students' discourse knowledge, the six questions were grouped into three sets of questions based on the constructs being measured: questions 1-2 for declarative knowledge of good writing, questions 3-5 for procedural and conditional knowledge of writing processes, question 6 for genre knowledge in narratives. When counting the idea units, the same or similar responses in these three grouped questions were not counted twice. For instance, if students mentioned handwriting in both question 1 and 2, only one idea unit was represented and the response type for this idea unit was production procedures (where handwriting falls). For each response type, its total number of idea units was summed. Therefore, the third step yielded 14 summed response type scores. The last step in scoring was to identify the most frequent and most theoretically important response types to represent different dimensions of discourse knowledge. Out of 14 response types scores, five major response types were used in the analyses: production procedures, substantive processes, story elements, motivation, and irrelevant. The rationale for choosing these response types was based on the theoretical and empirical importance, how discourse knowledge was conceptualized in the study, how it was represented in previous studies (Gillespie et al., 2013; Olinghouse et al., 2015; Olinghouse & Graham, 2009;).

Two undergraduate research assistants (RA) were trained to transcribe and score the interviews. One RA transcribed the interview, and 20% of the interviews were re-transcribed by the other RA to calculate transcription reliability. The inter-scorer agreement for interview transcribing was 100%. The RAs independently divided responses into idea units for 20% of the transcribed interviews. The inter-scorer agreement for idea unit segmentation was 93%. Each RA completed the segmentation for half of the samples (190 students). To establish scoring reliability, each RA independently scored 20% of the randomly selected interviews scored by the other RA. Percent of exact item-by-item agreement between the double-scored interviews for responses ranged from 87% to 98% (Question 1: 94 %, Question 2: 87%; Question 3: 98%; Question 4: 91%; Question 5: 88%; Question 6: 90%).

3. Results

3.1 Descriptive results

Table 1 presents demographic information. Descriptive statistics and correlation matrix can be found in Appendices B and C for all the variables. Overall, there were small to large positive correlations among control variables (range: .25 - .83). The control variables were positively related to the writing outcomes with small to moderate relationships (range: .18 - .42). Regarding discourse knowledge, the gain score was computed by subtracting the fall score from the spring score to measure the change in students' discourse knowledge across the school year. Results showed that the dominant interview responses in both fall and spring were production procedures and substantive processes. The mean of idea units for production procedures across all questions was 2.98 for fall and 3.22 for spring, which accounted for about 31% and 30% of the total number of idea units respectively. The overall means of the idea units for substantive processes was 1.32 for fall and 1.74 for spring, which accounted for 14% and 16% of the total number of idea units respectively.

To examine if the discourse knowledge variables had significant change from fall to spring, a paired-sample *t-test* was conducted. Four of the knowledge variables (substantive processes, story elements, motivation and irrelevant) had significant differences from fall to spring (Table 2). Variables that showed significant increases included substantive processes (t (379) = 4.04, p < .001; d = .18, Cohen's, 1988), story elements (t (379) = 5.04, p < .001; d = .26), and motivation (t (379) = 2.37, p < .001; d = .11). Irrelevant knowledge decreased with a small effect size (t (379) = -4.18, p < .001; d = .17). However, no statistically significant differences were found in the growth of production procedures (t (379) = 1.69, p = .09).

To address the research questions about the relationship between first-grade students' discourse knowledge and their end-of-year writing outcomes, two steps were taken. First, exploratory factor analysis (EFA) was used to determine if the number of control variables could be reduced to fewer factors. Second, hierarchical linear models (HLM) were fit to explore whether knowledge variables (either fall, spring discourse knowledge variables or discourse knowledge gain variables) predicted the writing outcomes (i.e., narrative length, descriptive length, narrative quality and descriptive quality) after controlling for student demographics and fall literacy achievement.

3.2 EFA Analysis

In order to reduce the number of writing-related control variables in the HLM analysis, an exploratory factor analysis (EFA) was conducted on the six control variables using promax rotation for factor extraction.

Table 2. Paired-Sample *t*-tests Comparing Discourse Knowledge from Fall to Spring (*N*=380)

	Sample Estimates		
	Gain Score Mean	t	p
Production Procedures	0.23	1.69	.09
Substantive Processes	0.42	4.04	<.001
Story Elements	0.51	5.04	<.001
Motivation	0.13	2.37	.02
Irrelevant	-0.32	-4.18	<.001

The Kiswer-Meyer-Olkin (KMO) tests showed that sampling was adequate for the analysis (KMO=0.78) (Field, 2009). Barlett's test of sphericity (χ^2 (15) = 1434, p <.001) indicated that correlations between these variables were sufficiently large for the factor extraction method of principle component analysis. Two components had eigenvalues over Kaiser's criterion of 1 and together they explained 77.82% of the variance. The screen plot showed inflexions that would justify retaining two components (Tabachnick & Fidell, 2013). Table 3 presents the rotated pattern matrix for the two-factor solution. The two factors were interpreted according to the magnitude and meaning of their salient pattern coefficients. All coefficients greater than 0.71 were considered strong and satisfied Comrey and Lee's (1992) standard for excellent loadings.

Table 3. Exploratory Factor Analysis for Fall Control Variables (N= 380)

	Rotated Factor Loading		
	Factor 1: Early Literacy Skills	Factor 2: Vocabulary Skills	Communality
PPVT-4		.96	.90
EOWPVT-4		.92	.89
Handwriting	.62		.38
Spelling	.93		.84
Letter-word ID	.93		.87
Word Attack	.87		.80
Eigenvalue	3.54	1.14	
% of Total Variance	58.82	18.99	
Total Variance	77.82		
Correlation between two factors	.46		

Note. Factor loading over .40 are reported; Rotation method: Promax with Kaiser normalization; Factor extraction method: Method of principle components.

The first factor was characterized by variables that measured early reading and writing skills. Assessments that loaded on the first factor included WJ-III Letter-Word Identification, WJ-III Word Attack, WJ-III Spelling and Handwriting. Consequently, the first factor was named early literacy skills, and this factor aligned with the theoretical and empirical importance of transcriptional and decoding skills for early literacy development (Berninger & Winn, 2006; Graham, 2006; McCutchen, 2006). The second factor was characterized by strong loadings on measures of oral language (PPVT-4 and EOWPVT-4). As a result, the factor was named vocabulary skills, and this factor also aligned with theoretical importance and empirical findings of oral vocabulary skills for early literacy development (Berninger & Winn, 2006; Graham, 2006; McCutchen, 2006).

3.3 Model building process

In order to analyze the role of discourse knowledge in students' writing outcomes, multilevel models were specified using HLM 7.0. For each sub-question, three different models were run and compared for each writing outcome in the model building process.

3.3.1 Model 1: Unconditional model

The first step in the model building process was to determine the amount of the total variation in students' writing outcomes accounted for at each of the two levels (i.e., student and classroom). The unconditional models for all the writing outcomes showed level-2 ICCs ranging from 5.4% to 22.3% (10.3% for narrative quality, 5.4% for descriptive quality, 22.3% for narrative length, and 14.2% for descriptive length). Except for descriptive quality, these percentages showed that there was a sufficient variance in the outcomes attributable to the classroom level (>10%). Therefore, the analyses for all the writing outcomes justified the use of HLM instead of multiple regression analysis (Field, 2009; Raudenbush & Bryk, 2002; Snijders & Bosker, 2012).

3.3.2 Model 2: Conditional model with Level-1 control variables and random intercept

The model with the control variables at level-1 without random slopes was tested next. This model was tested to determine whether the control variables (age, gender, early literacy skills and vocabulary skills) accounted for a significant amount of the total variation in students' writing outcomes as suggested by earlier research (Berninger & Abbott, 2010; Coker, 2006; Duin & Graves, 1986; Kim, Al Otaiba, Folsom, Greulich, & Puranik, 2014). In this model, all the four control variables were used as Level 1 predictors. Error variances of the level-1 predictors were not significant (i.e., the slopes did not vary across classrooms), and thus were treated as

fixed here (i.e., constrained to zero) rather than random across schools (i.e., at level 2).

3.3.3 Model 3: Conditional full model with all Level-1 variables and random intercept

The third model included all the five knowledge variables (either fall, spring discourse knowledge variables or discourse knowledge gain variables) as level-1 predictors, in addition to the predictors that were tested in model 2. Error variances of the level-1 predictors were determined to be not significant, and thus were treated as fixed here (i.e., constrained to zero) rather than random across schools (i.e., at level 2). The overall guiding HLM two-level model for our first research question could be broadly expressed as follows:

$$Y\,wrt_{ij} = \beta_{0j} + \beta_1(\text{Age})_{ij} + \beta_2(\text{gender})_{ij} + \beta_3(\text{early literacy skills factor})_{ij} + \beta_4(\text{vocabulary skill factor})_{ij} + \beta_5(\text{fall production procedures})_{ij} + \beta_6(\text{fall substance processes})_{ij} + \beta_7(\text{fall story elements})_{ij} + \beta_8(\text{fall motivation})_{ij} + \beta_9(\text{fall irrelevant})_{ij} + u_{oj} + e_{1j}$$

Simply put, the equation means the writing outcome for student i from class j is a function of many factors. It equals the average writing score across classrooms, plus the function of that student's age, gender, early literacy skills, vocabulary skills, and his/her fall discourse knowledge (represented by the fall scores of the five knowledge variables) plus some error *e* specific to that students and error *u* specific to the classroom the student is in.

In the models presented above, all variables used were grand mean centered. The model fit was evaluated by the likelihood-ratio test. During the model building process, fixed effects and random effects were fitted for Model 2 and Model 3. However, deviance tests showed that models without level-1 random slope fit the data better. Models were also compared based on the proportion of reduction in variance at both levels. The decrease of the variance component indicated Model 3 explained the variation in writing outcomes better than the previous models.

3.4 HLM Results

To address the research questions about the relationship between discourse knowledge variables (fall, spring, and knowledge gain) and writing outcomes, in total twelve final models were run using narrative quality, descriptive quality, narrative length, and descriptive length as outcomes. All these twelve models included control variables and one of the three sets of five discourse knowledge variables (either fall, spring, or gain). All final models included a random intercept but no random slopes.

3.4.1 Effect of control variables (age, gender, early literacy skills and vocabulary skills)

Table 4 presents the multilevel regression estimates for all the twelve final models. Across models, the control variable age was not a significant predictor. However, gender and early literacy skills were significant predictors. Girls were found to write better-quality and longer narrative and descriptive texts. Take as an example the models with fall discourse knowledge variables, the coefficients indicated that girls were estimated to score 0.29 points higher on narrative quality than boys, 0.43 points higher on descriptive writing quality. Likewise, girls were also estimated to write 7.66 more words than boys in the narrative task and 11.94 more words on descriptive writing. Early literacy skills were also found positively associated with both narrative and descriptive quality and length. However, vocabulary skills were significant predictors only for narrative quality and descriptive quality in models where discourse knowledge gain variables were used as predictors. Results showed that a one-unit increase in students' vocabulary skills was associated with 0.12-point increase in narrative quality and 0.13 points higher score in descriptive quality.

3.4.2 Effects of discourse knowledge variables (fall, spring or knowledge gain variables)

HLM analyses of models including fall, spring, and gain variables are presented according to the research questions. Regarding the first research question when fall discourse knowledge variables were included in the models as predictors, none of the fall discourse knowledge variables were significant predictors for final models predicting narrative quality and length. However, for final models predicting descriptive quality and length, fall production procedures was found to be a significant predictor with rather small estimate (i.e., a one-unit increase in knowledge of production procedures was associated with 0.05 points change in descriptive quality and with an increase of 1.16 words in descriptive length). Motivation was a significant predictor only for descriptive length (i.e., a one-unit higher score in motivation was associated with an increase of 3.55 words in descriptive length).

For the second research question where spring discourse knowledge variables were included in the models, spring production procedures was a consistent predictor across all four models predicting quality and length for both narrative and descriptive writing but with small estimates. In contrast, spring substantive processes and spring story elements were only significant predictors for narrative (quality and length), but not for descriptive writing. Spring motivation and irrelevant knowledge variables were not significant predictors.

Table 4. Multilevel Regression Estimates of Final Models Predicting Narrative Quality, Descriptive Quality, Narrative Length and Descriptive Length with Fall, Spring Discourse Knowledge and Discourse Knowledge Gain Variables (N= 380)

	Final Full Model Predicting Narrative Quality		Final Full Model Predicting Descriptive Quality		Final Full Model Predicting Narrative Length		Final Full Model Predicting Descriptive Length	
Variables	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Fixed effects								
Models with control variables and fall discourse knowledge as predictors								
Intercept (γ_{00})	3.28***	0.06	3.25***	0.05	33.47***	1.84	35.70***	1.82
Age	0.001	0.01	-0.01	0.01	-0.12	0.26	0.09	0.28
Gender	0.29**	0.09	0.43***	0.07	7.66***	2.25	11.94***	2.38
Early Literacy Skills	0.40***	0.05	0.36***	0.04	6.13***	1.30	6.06***	1.37
Vocabulary Skills	0.08	0.05	0.08	0.05	2.36	1.41	-0.81	1.48
Fall Production Procedures	0.03	0.02	0.05**	0.02	0.35	0.48	1.16*	0.50
Fall Substantive Processes	0.05	0.03	0.01	0.03	-0.06	0.79	-0.06	0.83
Fall Story Elements	0.01	0.03	0.02	0.03	0.003	0.82	-0.66	0.86
Fall Motivation	-0.07	0.06	0.05	0.05	-0.07	1.43	3.55*	1.51
Fall Irrelevant	-0.04	0.03	0.02	0.03	0.15	0.87	0.94	0.92
Models with control variables and spring discourse knowledge as predictors								
Intercept (γ_{00})	3.29***	0.06	3.25***	0.05	34.01***	1.89	35.18***	1.76
Age	0.001	0.01	-0.003	0.01	-0.03	0.26	0.11	0.27
Gender	0.30***	0.09	0.42***	0.07	6.78***	2.21	11.98***	2.35
Early Literacy Skills	0.36***	0.05	0.33***	0.04	5.08***	1.32	5.13***	1.39
Vocabulary Skills	0.02	0.05	0.09	0.05	0.31	1.41	-0.05	1.49
Spring Production Procedures	0.06**	0.02	0.05**	0.02	1.58**	0.51	1.19*	0.54

Spring Substantive Processes	0.07**	0.03	0.01	0.02	1.46*	0.70	-0.04	0.73
Spring Story Elements	.08**	.03	.02	.03	1.45*	0.69	-0.79	0.72
Spring motivation	-0.01	0.05	0.03	0.04	0.57	1.20	0.95	1.27
Spring Irrelevant	-0.01	0.05	-0.03	0.04	0.04	1.19	2.26	1.26
Models with control variables and discourse knowledge gain as predictors								
Intercept (γ_{00})	3.28***	0.06	3.25***	0.05	33.54***	1.78	36.65***	1.83
Age	0.001	0.01	-0.01	0.01	-0.09	0.26	0.10	0.28
Gender	0.34***	0.09	0.44***	0.07	7.79***	2.21	11.41***	2.37
Early Literacy Skills	0.42***	0.05	0.37***	0.04	6.07***	1.27	5.90***	1.36
Vocabulary Skills	0.12*	0.05	0.13**	0.04	2.46	1.31	-0.58	1.40
Production Procedures Gain	0.01	0.01	0.002	0.01	0.72	0.42	-0.03	0.45
Substantive Processes Gain	0.02	0.02	-0.01	0.02	0.85	0.57	-0.13	0.61
Story Elements Gain	0.05*	0.02	0.004	0.02	1.09	0.58	0.74	0.62
Motivation Gain	0.02	0.04	-0.01	0.03	0.16	1.04	-1.42	1.12
Irrelevant Gain	0.02	0.03	-0.03	0.02	-0.04	0.75	-0.01	0.81

Note. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

To answer the third research question about the relationship between gain in discourse knowledge and writing outcomes, only story elements gain predicted narrative quality with small estimates (i.e., a one-unit higher story elements gain score was associated with a 0.05-point increase in narrative quality). None of the other discourse knowledge gain variables were significant predictors of students' descriptive quality, narrative length and descriptive length.

4. Discussion

In this study, the role of discourse knowledge in first-grade students' writing was examined. Our findings indicated that students' knowledge did increase across a

school year; however, the results did not provide strong evidence that all types of discourse knowledge predicted writing achievement among beginning writers. For example, across the five types of discourse knowledge that were investigated, the only consistent findings were that students' spring knowledge of production procedures predicted writing achievement for both genres, and spring substantive processes knowledge and story elements predicted narrative achievement. We consider our findings in light of our original hypotheses and the previous research in this area.

The first hypothesis that first graders would demonstrate emerging discourse knowledge and that they would demonstrate more mechanical rather than the compositional knowledge was supported. The interview data revealed that first-graders showed an emerging knowledge about writing as evidenced by the relatively small overall means for the five discourse knowledge variables. Also, first-graders produced more mechanical-focused responses than composition-related responses. The hypothesis was further supported by the modest growth between fall and spring measures of discourse knowledge. Except for production procedures, all the other four knowledge variables had significant changes but with very small effect sizes. Additionally, our data revealed an increase in most types of discourse knowledge that would facilitate writing (i.e., substantive processes, motivation, and story elements) and a decrease in knowledge that would not be likely to strengthen writing (i.e., irrelevant knowledge). These findings signaled that writing knowledge develops with more schooling but that growth, especially across the same school year, was modest and limited (Kos & Maslowski, 2001; Lin et al., 2007;).

The second hypothesis that discourse knowledge measures would predict first-grade students' writing achievement was partially supported. By the spring of first grade, knowledge of production procedures was associated with the length and quality of both narrative and descriptive texts. Similarly, spring substantive processes and story elements knowledge predicted narrative length and quality. These findings aligned with previous research conducted with students in second and fourth grades that found knowledge of substantive processes predicted students' written vocabulary diversity and that production procedures and story elements predicted narrative quality (Olinghouse & Graham, 2009).

One explanation for the finding that production procedures was associated with outcomes for both genres may reflect the developmental challenges that young writers face with the transcription demands of composing. Production procedures knowledge includes the mechanical aspects of writing such as handwriting, spelling accuracy, and punctuation. For first graders, the challenges associated with handwriting and spelling demand considerable cognitive attention until they are automated (McCutchen, 1986). In fact, Berninger's Not-So-Simple-View of Writing positions transcription skills as critical components of the writing process (Berninger & Winn, 2006). Furthermore, there is considerable evidence that

handwriting and spelling are highly related to writing productivity and quality for young writers (Coker et al., 2018; Graham et al., 1997; Graham, Harris, & Fink, 2000; Kim et al., 2011; Kim & Schatschneider, 2017; Wagner et al. 2011). It may be that students' knowledge of production procedures may help them be more cognizant of how to use these features to strengthen their writing across genres, which might explain why the effect was found for both narrative and descriptive texts and for both length and quality measures.

One question is why only spring knowledge of production procedures, but not fall knowledge or students' knowledge gain, was related to writing achievement. Our results showed that there was no significant increase in students' production procedures knowledge from fall to spring, indicating that students did not have expanded production procedural knowledge to inform their writing. It could be that their production procedures knowledge was suppressed until students could actually do the transcription tasks well enough. This might occur because transcription was not well automated. Without sufficient transcription automaticity, students may experience what Kim and Park (2019) characterized as a "bottleneck phenomenon" where transcription difficulties inhibit students' ability to engage higher-level skills and knowledge (p. 1337). Although we do not have data on whether students' handwriting, spelling, and mechanics improved over the course of the year, it seems likely that they did. Certainly, by the spring, students had experienced a year of writing instruction and practice, and in this sample, teachers devoted a third of their writing instruction to the mechanics related to production procedures knowledge (Coker et al., 2016). Perhaps by the end of first grade, students' ability to transcribe words was stronger, and it allowed them to leverage their existing knowledge of production procedures to support their writing.

Some support for this position also comes from Saddler and Graham (2007) who found positive correlations between knowledge of substantive processes, production procedures, and motivation and fourth graders' writing achievement. However, those positive relationships were present only for the more skilled writers in their study. The authors suggested that the writing knowledge of less skilled writers was not well integrated, limiting its application during writing. Perhaps the null results from fall discourse knowledge and knowledge gain in this study may be explained by the inexperience of first graders in the fall of the school year. This interpretation aligns with how the Not-So-Simple View of Writing describes the interaction of text generation knowledge and transcription skills in a working memory environment (Berninger & Winn, 2006).

The results also revealed that knowledge of substantive processes and story elements were related to the length and quality of narrative texts. Knowledge of substantive processes includes information about writing processes, such as planning and revising. Knowledge of story elements refers to the understanding of genre knowledge in narratives. By the spring, students may have sufficient skill getting words on paper to integrate their growing genre knowledge and knowledge

about how to engage in writing processes. The importance of substantive processes knowledge and genre knowledge of story structure to writing achievement has been demonstrated in multi-component interventions with primary-grade students (Graham et al., 2005; Harris et al., 2006; Zumbrunn & Bruning, 2013) and older students in elementary school (Englert et al., 1988; Fitzgerald & Teasley, 1986; Olinghouse et al., 2015; Olinghouse & Graham, 2009; Saddler & Graham, 2007).

One question is why substantive process knowledge only predicted the narrative outcomes. It may be that students had little experience writing descriptive texts. As a result, they may not have been able to transfer their substantive process knowledge to a new genre. This could be investigated in future samples with students who experienced more instruction across genres.

However, not all aspects of our second hypothesis were confirmed. Nearly all measures of fall discourse knowledge and knowledge gain were unrelated to writing achievement. Across eight models using fall and gain discourse knowledge variables, only production procedures, motivation, and story elements gain reached the conventional level of statistical significance in any single model. Our measures of discourse knowledge only represented four significant effects out of 40 possible effects in these eight models, and there were no meaningful patterns in the results. These null findings did not support previous research with older students where knowledge of substantive writing processes and story elements were consistently predictive of writing (Olinghouse et al. 2009; 2013; 2015).

The lack of effect for fall measures of discourse knowledge may be due to limited writing knowledge and skills of beginning writers who have experienced little instruction or practice. Similarly, the lack of consistent relationships when modeling knowledge gain variables suggested that the modest growth between fall and spring was not great enough to make a difference in students' writing outcomes. The pattern of results found in the spring suggested that even achieving some facility with writing may allow students to access their funds of discourse knowledge.

There are also theoretical implications of these findings. In this study, the Not-So-Simple-View of writing model provided a useful theoretical foundation because it offered a framework of the way that component writing skills interact with each other and contribute to the writing process in a working memory environment. However, Berninger and Winn's (2006) model is static, and its developmental implications are unclear. Over time the relationships among writing skills may change as some become better automated and as writing knowledge expands. Researchers need more sensitive models of early writing that describe how component skills change over time and how that change influences their predictive power. Fully articulated theoretical models of writing development are currently beyond our grasp, but models such as the Direct and Indirect Effect Model have begun to address how components change over time (Kim & Park, 2019; Kim & Schatschneider, 2017). Our study also indicated that the knowledge-telling model

(Bereiter & Scardamalia, 1987) may not apply well to the very beginning writers given the fact that the model was developed out of data from nine-to-ten-year-olds, the age group for the upper-elementary-grades.

A second possible explanation for some of the null findings in this study may be related to our assessment of discourse knowledge. Specifically, we might have underestimated students' discourse knowledge using an interview protocol. When assessing discourse knowledge, one challenge is that young students may not be able to fully articulate what they know due to their developing meta-language or lack of vocabulary about discourse knowledge. As a result, students may have more developed discourse knowledge than they were able to discuss during the interviews.

In other studies, researchers have responded to this challenge by using indirect assessments of discourse knowledge. Alternative measures have included inferring students' discourse knowledge by analyzing students' written texts on what they know about how to write (McCutchen, 1986; Schoonen & de Glopper, 1996; Wray, 1993) . Schoonon and de Glopper, (1996) and Wray (1993) asked students to write a letter describing the attributes of good writing. Other possible approaches include presenting vignettes to elicit information about how students approach problems during planning, drafting, and revising (Englert et al., 1988), or observing teacher-student talk during writer's workshop (Kos & Maslowski, 2001). It is possible that some of these methods could be useful in assessing discourse knowledge with younger writers.

4.1 Limitations

When measuring students' discourse knowledge, the study adopted Olinghouse and Graham's (2009) protocol, which was limited to questions about narrative and planning process. Therefore, no interview questions were asked about students' revising processes and students' knowledge of descriptive writing. Adding these questions to the interview could provide more information about students' writing process knowledge and develop a more comprehensive picture of the knowledge-related predictors of early writing that are genre specific. Another limitation concerning the measures of discourse knowledge was the possibility that young students might have difficulty understanding the questions.

An additional limitation of the study was the lack of measures of students' topic knowledge and verbal skills. There is both theory (Bereiter & Scardamalia, 1987) and evidence indicating that topic knowledge is related to writing achievement (Benton et al., 1995; Graham et al., 2019; McCutchen, 1986; Mosenthal et al., 1985; Olinghouse et al., 2015; Voss et al., 1980). The inclusion of topic knowledge as a control measure would be useful because the relationship between discourse knowledge and writing performance could have been influenced by topic knowledge. However, in this study, the topics of both the narrative and descriptive prompts were designed

to elicit information about students' personal lives so that students would not have to access deep topic knowledge for the writing tasks.

With our discourse knowledge interview, it was possible that some students produced fewer responses due to weaker verbal skills rather than a lack of discourse knowledge. One way to assess the potential confound of linguistic knowledge would be to evaluate students' language skill. Saddler and Graham (2007) used an interview protocol and also included an assessment of students' syntactic proficiency. Including measures that assess a wider range of students' verbal knowledge would serve as stronger controls of verbal skill than the vocabulary skills measured in this study.

4.2 Implications

Findings from this study extended our understanding of the role of discourse knowledge in beginning writing. Additional research with this age group can further our understanding of early writing development. Specifically, cross-sectional and longitudinal work that explores the development of discourse knowledge and its relationship to writing achievement over time would be valuable. Longitudinal work on discourse knowledge would also help refine theoretical models of early writing. It is also important to investigate the other approaches to measuring beginning writers' discourse knowledge in the future. Researchers should consider collecting more comprehensive data by combining direct and indirect measures of discourse knowledge.

To have a more refined understanding of the relationship between discourse knowledge and writing outcomes, future studies could explore the question of whether and how discourse knowledge interacts with important writing-related factors to impact writing outcomes. It may also be possible that classroom instruction that enhances young students' discourse knowledge could strengthen writing achievement. Interventions with older students have demonstrated that instruction in specific components of discourse knowledge, such as text structure (Fitzgerald & Teasley, 1986) and writing processes (Gambrell & Chasen, 1991; McCutchen et al., 1997; Wong et al., 1996) can improve writing achievement. Future research could explore what instructional variables are important for students' acquisition of discourse knowledge and whether instruction in discourse knowledge improves writing, especially in early grades.

4.3 Conclusion

The current study investigated the relationship between first-graders' discourse knowledge and beginning writing. Overall, our findings showed that knowledge of production procedures and, to a lesser extent, substantive processes and story elements in the spring of first grade were related to students' writing achievement. Fall discourse knowledge and its growth across school year were not related to writing achievement. Thus, our study provided partial support for the importance

of discourse knowledge for early writing. Given the challenges of measuring discourse knowledge with young children, the results of the study should be interpreted with caution and call for more research with beginning writers. Overall, this study extended the findings of earlier research to beginning writers and deepened our understanding of the role of discourse knowledge in early writing.

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Appendix A: Narrative and Descriptive Writing Prompts Quality Scoring Rubric

Dimensions	1	2	3	4	5	6
Topic and supporting details	Does not include a complete idea, or the content is brief and unrelated to the prompt. It may be incomprehensible.	Topic is clear and related to the prompt. There are no details beyond the topic or any details are unclear or off topic. Or the topic is not clearly defined but a few details are related to the prompt.	Topic is clear. There is a single detail about the topic, a list of features, or multiple details loosely related to a topic.	Topic is clear. There are a few (2-4) simple details about the topic that stay on the topic. One or two details may be connected or briefly elaborated.	Topic is clear and the paper stays on topic. There may be multiple details (5+), or the details may be descriptive.	Topic is clear and the paper stays on topic. There are multiple details that are highly descriptive.
Organization and closure	No organization because there is insufficient information to organize.	May begin with a topic but otherwise there is no organization.	The topic is mentioned first followed by a detail. There is no closure.	The topic is mentioned first followed by details. In general, the sentences are related to the topic but not in any particular order. There is no closing statement or just a conventional ending (e.g., The End; It was fun.)	Organization of details is evident in the grouping or sequencing of details in some of the paper. Linking terms may be used but not for most of the paper. There is an ending that gives some sense of closure.	Organization of details is evident in most of the paper, and linking terms are used several times for most of the paper. Overall, the paper is coherent. There is an ending that gives a clear sense of closure related to the topic.
Word choice	A few simple words are used.	Words are common but related to topic.	Words are common but appropriate to the meaning.	Most of the words are common, but there is some variety of words.	Some less common words or specific words are used in description or to create a feeling.	Descriptive words are used to create images. Words are chosen to convey specific meanings. Words may be used in colorful and creative ways.
Overall						

Appendix B: Means, Standard Deviations and Range for All the Observed Variables (*N*=380)

	Descriptive Statistics		
Variable	*M*	*SD*	Min-Max
Control Variables			
Handwriting	5.09	2.51	0-15
WJ-III Spelling	106.47	13.72	65-147
WJ-III Word Attack	110.41	9.57	74-134
WJ-III	111.28	13.37	67-153
Letter-word Identification			
PPVT-4	102.13	13.63	58-141
EWOPVT-4	98.37	14.12	55-137
Knowledge Variables			
Fall Production Procedures	2.98	2.49	0-12
Fall Substantive Processes	1.32	1.55	0-11
Fall Story Elements	1.02	1.47	0-7
Fall Motivation	0.48	0.82	0-5
Fall Irrelevant	1.06	1.42	0-8
Spring Production Procedures	3.22	3.29	0-13
Spring Substantive Processes	1.74	2.28	0-15
Spring Story Elements	1.52	1.78	0-7
Spring Motivation	0.61	1.15	0-5
Spring Irrelevant	0.74	1.63	0-6
Production Procedures Gain	0.23	2.70	-8-11
Substantive Processes Gain	0.42	2.02	-10-12
Story Elements Gain	0.51	1.95	-7-6
Motivation Gain	0.13	1.08	-3-4
Irrelevant Gain	-0.32	1.50	-8-4
Writing measures			
Narrative Quality	3.31	1.00	1-6
Descriptive Quality	3.25	0.86	1-5
Narrative Length	34.70	25.11	2-147
Descriptive Length	35.39	24.89	4-170

Appendix C: Bivariate Correlations among Control Variables and Outcome Variables: Narrative and Descriptive (*N*= 380)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1 Handwriting		.45*	.37**	.43**	.25**	.28**	.18**	.10	.12*	.05	-.06	.15**	.13**	.13*	-.03	-.13*	-.04	.04	.02	-.07	-.04	.31**	.20**	.38**	.28**
2 Spelling			.75**	.83**	.36**	.40**	.17**	.17**	.23**	.04	-.20**	.17**	.28**	.18**	-.09	-.21**	-.01	.12*	-.01	-.11*	.05	.39**	.26**	.42**	.18**
3 WJWA				.83**	.39**	.45**	.17**	.20**	.22**	-.01	-.25**	.18**	.25**	1.67**	-.12*	-.27**	-.00	.07	-.02	-.10	.06	.40**	.25**	.41**	.08
4 WJLWID					.39**	.45**	.16**	.24**	.23**	.01	-.26**	.18**	.26**	.22**	-.10	-.24**	.01	.05	.03	-.09	.09	.40**	.26**	.43**	.14**
5 PPVT-4						.78**	.25**	.23**	.24**	.08	-.28**	.22**	.33**	.25**	-.02	-.23**	-.04	.12*	.05	-.08	.11*	.31**	.22**	.31**	.09
6 EWOPVT-4							.31**	.25**	.32**	.03	-.29**	.24**	.30**	.29**	-.10	-.25**	-.08	.09	.03	-.11*	.11*	.25**	.16**	.27**	.03
7 Fall Production Procedures								.02	.16**	-.12*	-.19**	.38**	.06	.15**	-.05	-.17**	-.60**	.06	-.09	.02	-.09	.15**	.08	.22**	.09
8 Fall Substantive Processes									.21**	.01	-.09	.08	.29**	.17**	.02	-.14**	.03	-.51**	.08	-.01	.09	.18**	.08	.14**	.01
9 Fall Story Elements										.06	-.22**	.03	.26**	.29**	.03	-.20**	-.01	-.01	-.49**	-.06	.13*	.16**	.07	.18**	.01
10 Fall Motivation											.08	-.08	-.01	-.02	.24**	.08	.07	.01	-.02	-.55**	-.05	-.06	.00	.03	.07
11 Fall Irrelevant												-.12*	.00	-.13**	.04	.27**	.02	-.06	-.01	.01	-.77**	-.19**	-.07	-.11*	.03
12 Spring Production Procedures													-.06	.05	-.16**	-.18**	.52**	-.10	-.07	-.10*	.04	.21**	.17**	.25**	.14**
13 Spring Substantive Processes														.30**	-.04	-.10	-.12*	.68**	.14**	-.04	.07	.27**	.22**	.15**	.22
14 Spring Story Elements															-.07	-.08	.01	.07	.70**	-.08	.13*	.24**	.17**	.15	.04
15 Spring Motivation																.12**	-.06	-.03	-.05	.68**	.001	-.08	-.03	-.07	-.04
16 Spring Irrelevant																	-.04	-.09	.02	.07	.41**	.17**	-.09	-.21**	-.01
17 Production Procedures Gain																		-.13**	.02	-.11**	-.05	.05	.07	.01	.04
18 Substantive Processes Gain																			.07	-.03	-.00	.11*	.14**	.03	.01
19 Story Elements Gain																				-.02	.02	.10*	.10	.01	.03
20 Motivation Gain																					.04	-.02	-.03	-.08	-.09
21 Irrelevant Gain																						.06	.01	-.03	-.04
22 Narrative Quality																							.75**	.52**	.34**
23 Narrative Length																								.42**	38**
24 Descriptive Quality																									.65**
25 Descriptive Length																									

Note. Control variables are Handwriting Fluency (HW), WJ-III Spelling subtest (Spelling), Picture Prompt Vocabulary Test (PPVT-4), Expressive One Word Picture Vocabulary Test (EOWPVT-4), WJ-III Letter Word ID subtest (WJLWID), WJ-III Word Attack subtest (WJWA); * $p<.05$; ** $p<.01$.