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Teaching Second-Grade Students to Write Expository Text

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ABSTRACT

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Writing is necessary to participate in public discourse. Much of today's communication is based on information, yet many students do not adequately learn how to write expository text. Learning to write is difficult, but expository text can be especially difficult as it requires knowledge of both a subject and special text structures. The purpose of this study was to give teachers a research-proven method for teaching students to write expository text and to give more information on how to evaluate students' writing.

In this quasi-experimental quantitative research design, the expository writing of students before and after receiving a new science and literacy integrated curriculum combined with specific expository writing instruction was compared. Participants included 71 second-grade students and 3 teachers from a suburban public elementary school in a Mountain West state. Students came from diverse socioeconomic, ethnic, and racial backgrounds. Measures included a holistic rubric that measured statement of purpose/focus and organization and conventions/editing, and an analytic rubric that measured introductions, facts on the topic, conclusions, word count, and the language mechanics of punctuation, capitalization, and spelling. A paired-samples t test of total scores from the holistic rubric showed statistically significant improvement pre-instruction to post-instruction ($p < .001$, two tailed). A paired-samples t test of total weighted scores from the analytic rubric also showed statistically significant improvement between pre-instruction and post-instruction ($p < .001$, two tailed). Wilcoxon signed-ranks tests were used to examine the individual elements of each rubric. All rubric elements showed statistically significant improvement except for three elements of the analytic rubric: topic introduction ($p = .664$), concluding statement ($p = .916$), and spelling ($p = .299$). Findings indicated that teachers could use the instruction to successfully teach students to develop content knowledge about an expository topic and write expository text based on that knowledge.

The ranks of scores for each rubric were also examined to see how the scores varied based on which rubric was used. The holistic rubric had fewer positive and negative ranks than the analytic rubric, and the holistic rubric had more tied ranks than the analytic rubric. It was therefore determined that the rubrics did not score similarly. Holistic rubrics give an overall impression while analytic rubrics allow the scorer to see the areas in which students excel and the areas which need improvement. Therefore, teachers and researchers should consider their purpose for scoring writing and use the rubric that will appropriately meet that purpose.

Keywords: integration, science, expository writing, rubrics

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CHAPTER 1

Introduction

Writing is an essential task in our society and its importance cannot be stressed enough (Duke, 2000; Wise, 2005). Effective writing skills are necessary for success in the modern workplace (Graham, Bolinger, et al., 2012; Wolbers et al., 2015), and writing is often necessary for gaining or advancing in employment (Troia & Olinghouse, 2013). Two-thirds of salaried positions in most industries require writing, and up to one-third of hourly employees are expected to write effectively (National Commission on Writing in America's Schools and Colleges, 2004; Graham, Bolinger, et al., 2012). Because so many of today's vocations require writing, it is important that students learn to write at an early age, so they are prepared to face the writing demands that are required of them throughout their education and well into adulthood.

Unfortunately, many students graduate from high school without the writing skills they need to be successful in higher education or employment (Cutler & Graham, 2008). Graham and Sandmel (2011) reported that just under a quarter of high school students were writing at or above grade level. Indeed, national writing assessments demonstrate that high school students lack effective writing skills (Graham et al., 2003; Harris et al., 2003; Harris et al., 2006; Helsel & Greenberg, 2007). This is a problem because high school students graduating without the writing skills that they are expected to have may lead to these students not being hired or not being admitted to college (Duke, 2000; T. Shanahan, 2015a).

The challenges associated with learning to write begin long before high school and start as early as when children are first learning to write. Researchers have demonstrated how learning to write is actually very complex and difficult (Harris et al., 2006; Graham, Berninger, & Abbott, 2012; Graham, Bolinger, et al., 2012). For example, writers are required to have detailed knowledge of the topic they are writing about (Graham et al., 2005; Harris et al., 2006), and writers must also understand how to use the writing process. This process includes planning, revising, and organizing the content (Graham, Berninger, & Abbott, 2012). Simultaneously, writers must be familiar with the mechanics of language, including spelling, punctuation, capitalization, and grammar (Graham et al., 2003; Santangelo et al., 2007). Finally, writers must carefully attend to their audience and constantly consider the clarity of their communication (Harris et al., 2003; Graham, Bolinger, et al., 2012). Thus, many students need help to overcome the challenges inherent in learning to write (Englert et al., 2009).

In an effort to help students overcome these difficulties, to help students learn to write for various purposes, and eventually to help students be college and career ready in the area of writing, the English Language Arts Common Core State Standards (ELA-CCSS) were created (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010; Fang, 2014; Kersten, 2017). These new standards place a heavier emphasis on writing at the elementary level than was required in previous standards (T. Shanahan, 2015a). The ELA-CCSS outline a more detailed progression of writing development than was articulated in previous standards (T. Shanahan, 2015a). The ELA-CCSS contain ten writing standards for each grade level, beginning in Kindergarten and up to Grade 12, with the expectations at each grade level becoming progressively more elaborate and difficult (T. Shanahan, 2015a). The ELA-CCSS describe this as a "'staircase' of increasing text complexity" (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010, p. 8). This progression is important because it allows students to slowly build upon prior knowledge as they develop their writing skills (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

Within these writing standards, students are expected to produce three different types of text: narrative, argumentative, and informative/explanatory text (Richards et al., 2012; T. Shanahan, 2015a). Though these same three types of writing were required in many of the previous state standards for writing instruction, little attention has been paid to specifically helping teachers teach young children to write informative/explanatory text (Clark et al., 2013). Reasons for this are varied, but historically, narrative reading and writing has been featured most prominently in the primary grades, while informative/explanatory text has been typically taught and used more prominently in the upper elementary grades (Chall & Jacobs, 2003; Duke, 2000; Maloch & Bomer, 2013; Yopp & Yopp, 2012).

Informative/explanatory text, or informational text, has been categorized as a type of nonfiction text (Duke & Bennett-Armistead, 2003; Maloch & Bomer, 2013), but informational text has historically been defined in varied and often contradictory ways (Stewart & Young, 2018; Young, 2017). First, the library community wanted to distinguish researched, fact-based nonfiction text from other forms of nonfiction (e.g., poetry and folktales), and so they defined informational text as nonfiction text designed to "present, organize, and interpret documentable, factual material" (Young, 2017, p. 31). The second definition of informational text used by many literacy researchers and educators defines informational text as text that presents factual information about the content areas such as science and social studies (Stewart & Young, 2018; Young, 2017). Finally, the ELA-CCSS describe the term informative/explanatory text much more broadly to include reference materials, forms, instructions, etc. (Young, 2017).

In an interview Young (2017) held with Melissa Stewart, author of science-related children's books, the term *expository* text was described as nonfiction text written in a way that "explains, describes, and informs in a clear, accessible fashion," as opposed to narrative nonfiction, which is written in a way that "tells a story or conveys an experience" (see Young, 2017, p. 31). For the purposes of the current study, the term expository text is used instead of informative/explanatory or informational text to reduce confusion associated with the meaning and definition of informational texts.

The exposure that young children are expected to have with expository text is a significant change and challenge for many primary grade teachers who reportedly use only limited amounts of expository text in their daily instruction (Duke, 2000; Dreher & Kletzien, 2016; Yopp & Yopp, 2012). Researchers have demonstrated how the amount of exposure to a genre is linked to the quality of student writing within that genre (Duke, 2000; Fang, 2014; Kamberelis, 1999; Maloch, 2008; McLurkin, 2003; Moss, 2004a). Thus, the disproportional use of narrative over expository text in the primary grades might suggest that these students have not been exposed to as much expository text, and as a result, may be less familiar with the genre (Mantzicopoulos & Patrick, 2011; Ness, 2011). Consequently, this situation may have an impact on young children's ability to write expository text.

Moreover, the increase in expository text may be challenging for many young children because of the inherent difficulty of expository text (Chall & Jacobs, 2003). In order to teach students to write expository text, teachers should recognize that expository text must be taught differently than other types of text (Pappas, 2006). In addition to being taught to use the writing process and to consider the writing mechanics that all writing instruction requires, expository text writing also requires students to develop content knowledge before writing. In this study, knowledge is defined as understanding gained through experience, study, investigation, or observation (Bollinger & Smith, 2001). Therefore, researchers have suggested that teachers should provide opportunities for students to read and discuss expository information shared in expository texts (Hebert et al., 2018), so students can then write about these topics.

Additionally, there are more text structures used with expository text than with narrative text, so students need help knowing how to organize and present the information they wish to share. The unique structures of expository text tend to make it more complex than other genres (Hall & Sabey, 2007; Ness, 2011). For instance, the text structures found in expository text include cause and effect, sequential, compare and contrast, problem and solution, and description (Armbruster et al., 1987; Englert & Hiebert, 1984; Meyer & Freedle, 1984). Meyer and Wijkumar (2007) demonstrated how explicitly teaching children about the text structures found in expository texts simultaneously increased students' ability to compose and comprehend expository text. Research suggests that mentor or exemplar texts being used to serve as models for how to write expository texts and how to present the information within them is beneficial (Gibson, 2008; Graham, Bolinger, et al., 2012; Hodges & Matthews, 2017). Despite the complexity inherent within expository text, teachers can successfully teach these structures and ways to write expository texts to young children to support them in their own writing of expository text (C. Shanahan & Shanahan, 2014).

While research has demonstrated that it is possible for teachers to teach young children how to write expository text (C. Shanahan & Shanahan, 2014), the way writing instruction has traditionally been organized could be problematic (Pearson et al., 2010). Historically, writing has been taught using literacy-only approaches. The first prominent literacy-only approach has been an emphasis on teaching writing skills focusing specifically on language mechanics including spelling, punctuation, capitalization, and grammar (Pollington et al., 2001; Yang, 2018). Another common literacy-only approach has been the Writer's Workshop, developed over thirty years ago through the work of Atwell (1987), Calkins (1986), and Graves (1983), and is still widely used (Calkins & Ehrenworth, 2016). According to Calkins and Ehrenworth (2016), Writers' Workshop establishes a daily pattern of mini lessons designed to emphasize text structure, the steps of the writing process, and to teach writing conventions (Atwell, 1987; Supovitz et al., 2002).

Two additional literacy-only writing instruction approaches that are commonly used in primary grade classrooms are Shared Writing and Interactive Writing (Hammerberg, 2001). Both approaches are organized as whole group instruction to create shared writing experiences in which teachers and students collaboratively create the structure and meaning of text as they compose it together (Jones et al., 2010; McCarrier et al., 2000). In Shared Writing, the teacher models writing for the whole class while students orally contribute, while in Interactive Writing, the students take turns adding their own written contributions to a collective classroom piece (Hammerberg, 2001; Button et al., 1996). All of these literacy-only approaches have value, but they are limited in helping young children learn to write expository text as they do not allow time or instruction related to assisting children as they develop the content knowledge they need before they write in depth about a specific topic.

Because the ELA-CCSS were designed to be taught within the various disciplines, it is important to consider writing instruction that has been integrated with other disciplinary subjects (T. Shanahan, 2015b; Zygouris-Coe, 2012). In the current study, integrated instruction is defined as the teaching of two subjects simultaneously in a manner which benefits learning in both subjects (Weiss, 2006). Many researchers have recommended integrating literacy instruction along with content area subjects such as science (Casteel & Isom, 1994; Furner & Kumar, 2007; Graham, Bolinger, et al., 2012; Hancock, 2008; T. Shanahan & Shanahan, 2008; T. Shanahan, 2015a). Science is a rich and complex discipline with many concepts and phenomena to study (Cervetti et al., 2005; French, 2004). Furthermore, science has a literacy all its own, with its specialized ways for reading, writing, and thinking (Fang, 2005), and these disciplinary practices are supported by the literacy practices of reading and writing (Pearson et al., 2010). For this reason, science is ideal to integrate with literacy instruction, and researchers have used several approaches to do so.

One instructional approach that has integrated both science and literacy instruction in order to produce student gains in literacy is known as Concept-Oriented Reading Instruction (CORI). The main emphasis of this instruction is to increase reading comprehension and reading motivation by using science exploration to stimulate reading and writing tasks (Guthrie et al., 1994; Guthrie et al., 1998). While one study found that CORI students performed better than non-CORI students on a statewide writing assessment (Guthrie & Alao, 1997), there was no information provided on the type of writing that was included in these state assessments, and no other CORI studies investigated its influence on student writing. Moreover, CORI has been typically taught in upper elementary classrooms rather than in primary grade classrooms.

Similar to CORI, the In-Depth Expanded Application of Science (IDEAS) instructional approach, designed by Romance and Vitale (2001), is a model for science inquiry that is embedded within literacy activities. Romance and Vitale (2001) presented a framework for instruction that included both teacher-demonstrated and student-led science experiments, expository text reading, and expository writing activities (Romance & Vitale, 2001; Romance & Vitale, 2008). A five-year study of the IDEAS framework explored the extent to which scientific learning, problem solving abilities, and reading achievement increased as a result of the IDEAS instruction (Romance & Vitale, 2001). However, writing proficiency has not yet been studied following the IDEAS instruction.

Finally, a third integrated science and literacy instructional approach entitled Guided Inquiry Supporting Multiple Literacies (GIsML), focused on science inquiry and the reading of expository texts to support this inquiry (Magnusson & Palincsar, 1995; Palincsar et al., 2002). While this approach does suggest that teachers should focus on teaching students to construct scientific explanations, GIsML only requires that students keep a science journal to explain scientific phenomena through writing, and drawing diagrams (Palincsar et al., 2002). Thus, GIsML lacks a more sophisticated approach to writing instruction that is needed to teach students the structures and organization of expository text and the instruction needed to help young children write expository text effectively.

While CORI, IDEAS, and GIsML have been proven to be effective for teaching science and reading to children, they have not been used specifically for writing instruction. Similarly, literacy-only approaches such as Writer's Workshop, Shared Writing, and Interactive Writing have been used largely to teach children to write narrative text and are limited in their ability to support young children as they learn to write expository text. Therefore, there is a need for an instructional approach that integrates both science and literacy instruction to help students develop knowledge about a science topic *combined with* the need for instruction that teaches children to specifically write expository text. In this study, a new instructional approach was introduced and examined that attended to both of these needs to determine the influence this new method of teaching expository writing had on student writing. This integrated science and literacy instruction aligns with the writing and science standards that are currently required at state and national levels.

In addition to the lack of instructional approaches designed to teach young children to write expository text, there is also very limited information about how teachers should evaluate the expository text produced by children. Researchers and teachers alike have been known to use a writing rubric to evaluate student writing (Mertler, 2000). Jonsson and Svingby (2007) outlined the benefits of using a rubric to evaluate student writing as the following: (a) rubrics allow for the reliable scoring of student writing to be enhanced, (b) rubrics promote student learning, (c) rubrics improve instruction, (d) rubrics reflect and emphasize the various components of writing (e.g., conventions, content, spelling) that should be considered in student writing, and (e) rubrics make the expectations and criteria for evaluating student writing explicit. There are also two types of rubrics that are typically used—an analytic rubric and a holistic rubric—but little information exists about how well students perform on both forms of assessment rubrics. More information is needed to compare how students perform when teachers use either a holistic or analytic rubric.

Statement of the Problem

The adoption of the ELA-CCSS has created significant changes regarding the types of writing that are expected to be taught in the primary grades, with little information provided on how teachers are to meet these instructional goals and provide feedback for students about their writing (Graham et al., 2015; T. Shanahan, 2015a). Currently, teachers report an eclectic approach to their writing instruction (Cutler & Graham, 2008). Given the need for support young children have at the early stages of their writing, it is important that schools and educators are provided with evidence-based recommendations for writing instruction designed to teach young children to write expository text and recommendations for how to evaluate the writing young children produce. Specifically, more research is needed that explores the influence of integrated science and literacy instruction that supports young children as they develop and construct knowledge on a science topic combined with instruction that teaches writing conventions, text features, text structures, and signal words appropriate for use when writing science expository text. Currently, there is a dearth of research available on how to teach young children to write science expository text and little to no information regarding the most effective writing rubric to use in evaluating the science expository text produced by young children.

The purpose of this quantitative study was to examine the influence of an integrated literacy and science instructional approach combined with a writing instructional strategy designed specifically to teach second graders to write science expository text. Secondly, understanding how student writing scores vary based on the rubric being used to score writing samples is also needed. A study such as this can provide much needed information about how instruction and assessments, such as writing rubrics, can be orchestrated to support young children in learning to write complex expository text.

Research Questions

The research questions used in this study were as follows:

1. How does an integrated science and literacy instructional approach combined with a writing instructional strategy designed specifically for teaching expository text influence the science expository text written by second-grade students?
2. Do student rubric scores on the writing samples vary based on whether writing samples are scored using a holistic or analytic rubric?

CHAPTER 2

Review of Literature

A review of literature was conducted to evaluate and synthesize the research that has been published on the topic of teaching children to write expository text and the findings from this literature review are presented in this chapter. A discussion of the theoretical lens that guided this study is presented first, followed by a review of the literature on writing instruction generally and on teaching students to write expository text and science expository text specifically. Finally, a discussion and review of the research literature available on writing rubrics to evaluate student writing are shared.

Theoretical Framework

In this study, an integrated science and literacy curriculum instructional approach combined with a writing strategy used to teach children to write expository text was examined to see how this instructional approach influences the expository writing produced by second graders. Considering the heavy influence of the teacher, the mentor text, and the peer collaborations within this proposed instructional method, the sociocultural theory (see Kozulin, 2002; Scott & Palincsar, 2009) introduced in the early twentieth century was most relevant.

Vygotsky and others believed that one cannot understand a child's development without also considering the environmental and cultural factors surrounding and influencing the child (Gallimore & Tharp, 1990; Vygotsky, 1978; Wertsch, 1993). Vygotsky (1978) explained that "learning and development are interrelated from the child's very first day of life" (p. 84). The sociocultural theory emphasizes that learning and psychological development are the result of the interaction between the natural human maturation process alongside sociocultural influences (Gallimore & Tharp, 1990; Kozulin, 2002; Scott & Palincsar, 2009). These sociocultural influences include parents, peers, teachers, the community, and the child's environment. The interactions are either interpersonal (between the child and another person) or object-related (between the child and an object) (Kozulin, 2002). Specifically, Vygotsky explained how cognitive development and learning happens twice: first interpersonally in the social plane through interactions with others, then in an intra-personal process in which a child internalizes information in a psychological plane (Everson, 1991; Gallimore & Tharp, 1990; Glick, 2004; Wells, 1994).

Moreover, Vygotsky (1978) claimed that "what children can do with the assistance of others might be in some sense even more indicative of their mental development than what they can do alone" (p. 85). Armed with this belief, Vygotsky developed the concept known as the zone of proximal development, which Hedegaard (1996) described as a connection between child development and teaching practice. Vygotsky (1978) defined this zone of proximal development as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Described succinctly, the zone of proximal development is the distance between the actual developmental level of the child, what he or she can do independently, and the potential developmental level, what he or she can do with assistance (Vygotsky, 1978; Wertsch, 1993). This assistance is crucial for development within the zone of proximal development (Cicconi, 2014), and the term "more knowledgeable other" is used to describe these adults and peers who provide assistance (Abtahi, 2017; Blake & Pope, 2008; Hodges, 2017; Huong, 2007; Nurfaidah, 2018).

Gallimore and Tharp (1990) described Vygotsky's zone of proximal development as a relationship between social control and self-control. In their model, Gallimore and Tharp (1990) described how learning occurs throughout four stages of development. In the first stage, others who are more knowledgeable assist task performance, and understanding begins building through conversation (Gallimore & Tharp, 1990). The first stage transitions into the second stage when the learner can assume responsibility for tasks (Gallimore & Tharp, 1990). In the second stage, a child can talk themselves through a task, a phenomenon called self-directed speech (Gallimore & Tharp, 1990). In essence, a child is self-assisted in this stage, but performance or ability is still underdeveloped (Gallimore & Tharpe, 1990). Internalization occurs in stage three when no assistance is needed; actions become automatic. Stage four is when a child encounters further difficulty, triggering a re-entrance into the zone of proximal development (Gallimore & Tharp, 1990). This cycle continues throughout the lifetime of an individual (Gallimore & Tharp, 1990).

Applying sociocultural theory to teaching emergent writers has been widely documented (Bodrova & Leong, 1998; Bomer, 2003; Everson, 1991; Hodges, 2017; Nurfaidah, 2018; Vanderburg, 2006). Thompson (2013) emphasized that when students work within the zone of proximal development, the social learning that occurs is learning in its most powerful form. This is because the social interaction with peers and adults results in the acquisition of intellectual skills and a strengthening of shared meaning (Nurfaidah, 2018). Because the journey through the zone of proximal development begins as a social process (Bodrova & Leong, 1998; Nordlof, 2014; Nurfaidah, 2018; Thompson, 2013; Vanderburg, 2006), students gain greater capability to write when they can converse with peers and teachers, who can serve as "more knowledgeable others," before and during writing tasks (Everson, 1991; Hodges, 2017; Nurfaidah, 2018;

Vanderburg, 2006). Indeed, Emig (1977) emphasized that talking was an essential form of pre-writing.

Scaffolding is a term that describes the assistance provided to help students complete a complex task (Bodrova & Leong, 1998), such as writing science expository text (Clark & Neal, 2018). Examples of scaffolding used during instruction include group work in which members of a group help each other through tasks and think alouds that allow opportunities for the teacher to guide student thinking using questions (Bodrova & Leong, 1998). In essence, teachers can use scaffolding as part of the writing instruction itself to help students develop their knowledge on a science topic and to allow opportunities to discuss what they are learning within the zone of proximal development. In this way, students are allowed to write about and discuss ideas as a group before they learn to write independently and without assistance.

Furthermore, Vygotsky believed that all learning, including writing, is socially mediated through the use of both physical tools (e.g., books, paper, and pencils) and psychological tools (e.g., language; Thompson, 2013; Wertsch, 1993). These tools used within a culture or environment can help the learner develop and construct knowledge (Bomer, 2003; Imbrenda, 2016; Scott & Palincsar, 2009; Thompson, 2013; Wells, 1994). Tools for writing include environmental tools (e.g., desks and chairs), pages (e.g., paper and notebooks), writing characters (e.g., letters, numbers, and spellings), and procedural tools (e.g., classroom experiences, read alouds, instruction; Bomer, 2003).

Because learning to write is seen as a social activity within the context of sociocultural theory, educators and researchers should also be mindful of the socially interactive activities involved in the writing process, including reading, writing, speaking, and listening (Emig, 1977; Thompson, 2013). Written language grows from oral language (Vanderburg, 2006); therefore, a socially constructed writing environment that contains reading, writing, speaking, and listening becomes essential (Thompson, 2013).

Historical View of Writing Instruction

Historically, researchers have identified writing instruction as being literacy-only, meaning not combined with other disciplines, and has typically been taught in two different ways. These ways include a product-oriented instruction or a process-oriented instruction (Yang, 2018). Writing instruction in the U.S. dates back to the colonial days of American history, when children were taught grammar so they could read religious text (Funk & Funk, 1989). Product-oriented writing instruction emphasizes language mechanics skills including phonics, grammar, punctuation, and spelling (Funk & Funk, 1989; Pollington et al., 2001; Yang, 2018). Product-oriented writing instruction is a decidedly teacher-controlled approach (Bartlett, 1994; Pollington et al., 2001), which positions the teacher as a judge of student work (Yang, 2018). Little writing is actually taught or practiced, and some believe the act of writing occurs for assessment purposes (Pollington et al., 2001; Tidwell & Stele, 1992). Product-oriented writing instruction is limited in its effectiveness because students spend little time actually practicing writing. Despite this limitation, this type of writing instruction was the mostly commonly used writing instruction into the 1990s (Pollington et al., 2001; Yang, 2018) and is still used, though less frequently, today (Steele, 2004).

In contrast, process-oriented writing instruction focuses on the writing process including brainstorming, drafting, editing and revising, and publishing (Graham & Sandmel, 2011), and the final product is simply part of that process. Students have a purpose and an audience for writing, may write over extended periods of time, and take ownership over their writing with teacher support (Graham & Sandmel, 2011). The teacher is therefore positioned as a facilitator, not a judge (Yang, 2018), and process-oriented instruction therefore better aligns with sociocultural theory's notion of a "more knowledgeable other" providing assistance (Everson, 1991). A study in the early days of process-oriented writing instruction found that students taught with this approach performed significantly better on writing assessments than students taught using product-oriented writing instruction (Bruno, 1983). Varble (1990) also found that process-oriented instruction helped second-grade students improve the overall quality of their writing content. Additionally, Troia et al. (2009) found that process-oriented writing instruction is beneficial for helping writers improve sentence fluency, word choice, spelling, and conventions.

Furthermore, in their meta-analysis of research on the effectiveness of the process-oriented writing instruction, Graham and Sandmel (2011) found that using a process approach improved the overall quality of student writing. Indeed, Yang (2018) found that a process approach not only gave students a lot of practice writing, but students who used it had a good understanding of their own writing. However, researchers found a lack of direct instruction on writing strategies (Cutler & Graham, 2008) and determined that not enough attention is given to teaching language mechanics (Nagin, 2006, as cited by Graham & Sandmel, 2011). Additionally, researchers have identified common practices within process-oriented writing instruction to be notetaking, journal writing, summarizing, and writing personal narrative (Cutler & Graham, 2008; Gilbert & Graham, 2010; Mo et al., 2014). Despite the focus on process, writing instruction has often still limited to an average of only 30 minutes per day (Cutler & Graham, 2008) and this instruction has been too focused on students passing end-of-year assessments (Mo et al., 2014). There is also a lack of research indicating how well the product- and process-oriented approaches work specifically for teaching expository text writing.

Despite these approaches to teaching writing, researchers suggest that youth struggle with writing (Graham et al., 2003; Harris et al., 2003). Alarmed by this, the National Commission on Writing in America's Schools and Colleges (2003) identified writing as the neglected "R" of reading, writing, and arithmetic education. They implored states to revisit their core standards and put more emphasis on writing instruction at every grade level and across the curriculum; writing is a way for students to develop their understanding, and not just an assessment tool. The ELA-CCSS represent a significant shift in writing instruction (Goatley, 2012). Writing instruction, however, has been slow to evolve. In 2012, the Institute of Education Sciences and the What Works Clearinghouse issued a report on writing that included four research-based recommendations for teaching writing. These included the following: (a) provide time each day for students to practice writing, (b) teach students to write for various purposes using the writing process, (c) teach handwriting, sentence construction, spelling, typing, and word processing skills, and (d) create a writing community (Graham, Bolinger, et al., 2012). Furthermore, Mo et al. (2014) revisited the notion of the neglected "R," calling on educators to seize the opportunity provided by the ELA-CCSS to make changes to writing instruction. Mo et al. called these standards representative of best practices for writing instruction. In short, educators must pay more attention to writing instruction, particularly to the types of writing instruction that support a variety of writing purposes and genres. Because expository text is one of the genres and types of writing instruction that has been frequently neglected in the primary grades (Chall & Jacobs, 2003), the next section provides a review of how expository text has been used in the classroom.

Expository Text in the Classroom

Researchers have historically conducted research on the use of expository text with students in the secondary grades (Hall & Sabey, 2007; McGee & Richgels, 1985). One reason is the belief that children are more successful with expository text comprehension in the upper grades, as this is when their knowledge of discourse types increases (Englert & Hiebert, 1984). Hodges and Matthews (2017) also felt expository text was ideal for older students, because expository text builds students' literacy abilities of "thinking critically, recognizing issues of global concern, developing the capacity to identify key environmental and civic issues that must be addressed, and analyzing [these concepts] from multiple perspectives" (p. 74). These and other studies offer good insights into the use of expository text, but they fail to consider the importance of expository text for use with young children. Comparatively little research has been done concerning the use of expository text with young children (Li et al., 2018). This is changing, however, as the ELA-CCSS accelerated the need for studies in the early elementary grades as a result of the higher expectations for young children in the area of literacy (Wright & Gotwals, 2017a).

One reason expository text is important for young children to learn to read and write is because it is so abundant in society (Atkinson et al., 2009; Duke, 2000; Duke, 2004; Duke & Bennett-Armistead, 2003; T. Shanahan & Shanahan, 2008). Indeed, possessing the ability to read and write expository text is a necessity for success in our information-driven world, and children must learn to both read and write expository text to learn to communicate effectively (Bradley & Donovan, 2010). It is therefore important that young children be exposed to and have experience reading and writing expository text in their schooling, so they are prepared for this kind of communication in adulthood.

Students must learn to read and write expository text eventually and beginning at earlier ages will help them in later schooling (Duke & Bennett-Armistead, 2003). Hall and Sabey (2007) claimed that students need considerable exposure to expository text in the primary grades to provide children with a foundation for later literacy success. Similarly, Mantzicopoulos and Patrick (2011) asserted that reliance on fictional narrative alone in the primary grades did not give students the comprehension skills needed to comprehend expository text in upper grades. If children are familiar with and read lots of expository text in earlier years, it is less difficult for them to read increasingly more complex text as they age (Duke & Bennett-Armistead, 2003). This is also true of writing, and the increasing difficulty of the ELA-CCSS is designed to help students slowly build upon prior writing knowledge so they are prepared for more difficult writing in later grade levels (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). To introduce expository text writing in the primary grades, Grysko and Zygouris-Coe (2019) recommended that strategies used in the upper elementary grade levels be adapted and scaffolded for use with younger children. For example, older students often write in science journals, and even young children can be guided to use journals to record information in words or pictures during science activities (Grysko & Zygouris-Coe, 2019). Despite this recommendation, there is still little research into how to teach expository writing to younger children.

Additionally, expository text is important to include in classroom instruction because many young children actually prefer it over other types of text (Caswell & Duke, 1998; Duke & Bennett-Armistead, 2003; Mantzicopaulos & Patrick, 2011; Pappas, 1993; Repaskey et al., 2017). Caswell and Duke (1998) described two case studies where two young children who struggled greatly with all aspects of literacy began to demonstrate progress once they were introduced to expository text (Caswell & Duke, 1998). The expository texts fostered the children’s interests and served as a way for them to enjoy and find purpose in reading and writing (Caswell & Duke, 1998). Expository text also often addresses student questions or interests and builds their knowledge of the world (Duke & Bennett-Armistead, 2003). Maloch (2008) likewise found that expository text was a good resource for second-grade students to find answers to their questions about the world around them. Furthermore, Guthrie and colleagues (1996) found that when students use expository text to search for the answers to their questions, it led to higher achievement and motivation.

Using expository text during instruction has also been shown to help build vocabulary and develop visual literacy in young children, such as the ability to read tables and diagrams (Duke & Bennett-Armistead, 2003). Williams et al. (2005) studied second-grade students receiving three different types of expository instruction – one that focused on text structure, one that focused on content, and a control group that received traditional instruction. Williams et al. (2005) found that all students were able to include the vocabulary and content in their writing. Furthermore, students in the text structure group were able to transfer that learning to other content (Williams et al., 2005). This promising research shows that young students should be taught expository text structures to help develop their visual literacy, and more research is needed in this area.

A common myth held by teachers is that expository text is too difficult for children to read and understand (Duke & Bennett-Armistead, 2003; Ness, 2011). Many studies, however, refute this claim. For example, Pappas (1993) found that young children could learn the lexical knowledge necessary to read, reenact, and discuss expository books just as easily as they could with narrative books. Furthermore, researchers have found that young children are also capable of reading expository books, comprehending and retelling expository text presented orally, and enjoy doing so (Duke & Kays, 1998; Moss, 1997). Indeed, Duke and Bennett-Armistead (2003) found that struggling first grade students who were exposed to varying genres that included expository text in their literacy curriculum made greater gains in spelling, punctuation, and capitalization than their higher-performing peers whose instruction did not include expository text. Researchers also noted how children could summarize, infer, and make connections when reading expository text (Moss, 1997). Indeed, young students can not only understand expository text structures, they can also be taught to use these structures in their own writing (Bradley & Donovan, 2010; Clark et al., 2013; Clark & Neal, 2018).

Teaching Children to Write Expository Text

According to the ELA-CCSS, students cannot rely only on being able to read expository texts; they must also be able to write expository text. There is a plethora of the research that has explored how to teach children to read expository text, but very limited information is available that has explored how to best teach children to write expository text (Fang, 2014). Teaching students how to write expository text is important at all grade levels is expected, not only in the higher grades (see National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Even young children can participate in writing activities (Jaus, 1990; Wright & Gotwals, 2017b). For example, after studying the writing of first and second graders who wrote research reports, Read (2005) concluded that young children are indeed capable of handling the complexity of both reading and writing expository texts. Furthermore, Fang (2014) studied third, fourth, and fifth-grade students writing reports and found that each grade level made improvements on certain writing features over the other grade levels, suggesting that learning to write is feature-specific and not grade-specific. More research is needed to see how young children handle the complexity of writing expository text.

Many researchers agree that there is a relationship between exposure to expository text and being able to write expository text (Duke, 2000; McLurkin, 2003). Exposing children to different kinds of text is important because there is a close relationship between the types of text with which they are familiar and the types of text children can write well (Dollins, 2016; McLurkin, 2003). Duke and Bennett-Armistead (2003) likewise found that young children with more exposure to expository text were able to write higher quality informative/explanatory text. Furthermore, children without much experience with reading and writing expository text develop their ability to write expository text at a slower rate than children with more experience with expository text (McLurkin, 2003). Interestingly, Kamberelis (1999) found that even though young students were able to produce well-written stories, they struggled to write expository text. Researchers attributed these results to the students' high familiarity with narrative text and low familiarity with expository text (Kamberelis, 1999), further supporting the need for more exposure to both reading and writing expository text. Moreover, Kamberelis (1999) concluded that a "student's literary diets are not particularly well-balanced and may not be providing children with cultural staples requisite for optimal genre development and learning" (p. 452). Indeed, students must learn to read and write a variety of texts to be able to communicate for a variety of purposes (Kamberelis, 1999).

Teaching Children to Write Science Expository Text

One way to strengthen writing instruction for writing expository text is to integrate it with a content area such as science (Jaus,1990). Science provides many opportunities for students to learn to write expository text, and this form of writing can also promote different kinds of thinking (Hand et al., 1999). Because there are so many varied topics of study within science, it provides a great context for students to practice using several texts structures of expository text. For example, students can learn to write sequential text when studying plants, cause and effect when studying light (Cervetti et al., 2012), or problem and solution when studying pollution of ecosystems (Chambliss et al., 2003). Wright and Gotwals (2017b) explained that even at the early ages, “writing and drawing about science reinforces science learning and emergent writing skills” (p. 517). Hand et al. (2002) found that student writing products improved as students learned to write using various structures and for varying purposes within the science context.

Grysko and Zygouris-Coe (2019) also advocated for teachers to integrate science and literacy instruction so that students can learn to read, write, and communicate in science-specific ways in order to fully realize a deeper understanding of science. Integration occurs in three ways, including the use of overarching themes to connect two disciplines, the use of content or processes from one discipline to support another, and the equal balance and time during instruction given to at least two disciplines (Cervetti et al., 2012; Stoddart et al., 2002). In fact, writing is crucial in the study of science, as scientists use writing in many ways to communicate including the recording of procedures, taking notes, chronicling observations, reporting data, and communicating findings, ideas, and arguments (Grysko & Zygouris-Coe, 2019).

Moreover, science presents a unique opportunity for students to write expository text within a scientific domain. Science has its own form of discourse, and this discourse surrounding scientific texts provides a way for children to develop deeper thinking (Avalos et al., 2017). Scientific discourse is the way scientists communicate within the context of science (Kelly, 2015). As students participate in hands-on science exploration, read science expository texts, learn technical science vocabulary, take notes, record data, and write explanations, they are learning this discourse. They are learning the ways scientists read, write, listen, speak, question, observe, record, research, and write (Rosebery et al., 1992). As students learn to write within a science context, they participate further in scientific discourse by using the linguistic features typical of science expository text (Avalos et al., 2017). Teaching students to write expository text during science instruction also enables students to behave like scientists as they refine and consolidate scientific knowledge, reason and persuade, communicate understanding, and engage in reflection, which may help them see writing itself as worthwhile (Grysko & Zygouris-Coe, 2019).

Identifying Unique Characteristics

Science expository text contains all the elements described previously in the description of expository text (Purcell-Gates et al., 2007). However, there are additional organizational and lexicogrammatical characteristics in science expository text that differs from typical language use in other texts (Avalos et al., 2017; de Oliveira & Lan, 2014), and which sets science expository text apart from other expository text. These characteristics make scientific communication more efficient but may pose challenges for students who lack knowledge in science language use (Avalos et al., 2017; Fang, 2014), which is detailed in the following paragraphs.

One characteristic is technicality, because the language of science contains many technical terms and definitions that are specific to science (Avalos et al., 2017; de Oliveira & Lan, 2014; Fang, 2005; Grysko & Zygouris-Coe, 2019). Words that exist in everyday language may have a specialized meaning in science (de Oliveira & Lan, 2014). For example, within a science context, the word alien means a non-native species rather than an extra-terrestrial being. Students must learn this vocabulary to successfully communicate scientific understanding. T. Shanahan and Shanahan (2012) also explained that science expository text needs to be explicit and precise because "scientific claims are used to predict future reactions under similar conditions; even life and death can turn on the accuracy of scientific information" (p. 14). Avalos et al. (2017) found that students struggled to use technical vocabulary in their science writing, particularly students who already struggled with writing generally.

Another characteristic is informational density. Science expository text has a high lexical density, meaning it has a high number of technical vocabulary words per number of words overall (Avalos et al., 2017; de Oliveira & Lan, 2014; Fang, 2005; Fang, 2014; T. Shanahan & Shanahan, 2008). Science expository text also contains a large number of big ideas, core concepts, and key relationships (Fang, 2013). An additional feature, which also contributes to lexical density, is nominalization (Avalos et al., 2017; de Oliveira & Lan, 2014), in which a noun is created from a verb (e.g., act is changed to action). Avalos et al. (2017) found that only the highest-performing young writers could successfully use nominalization.

Authoritativeness is also a characteristic unique to science expository text (Avalos et al., 2017; de Oliveira & Lan, 2014; Fang, 2014). Authoritativeness is presenting material with objectivity, without bias. This includes using timeless verbs and generic noun constructions (Purcell-Gates et al., 2007). An example of timeless verb use is "Birds eat seeds" rather than "Birds ate seeds." An example of generic noun construction is "Birds eat seeds" rather than "That bird eats seeds" or "Bob the bird eats seeds." Researchers found that third grade students, especially struggling writers, struggled to use timeless verbs (Avalos et al., 2017), yet other researchers reported success with students learning to use timeless verbs (Fang, 2014). It is important for teachers to consider the technicality, informational density, and authoritativeness when teaching students to write expository text, because these are difficult concepts to master and may be problematic for young writers.

Focusing on Scientific Elements

Grysko and Zygouris-Coe (2019) maintained that the elementary science classroom is the perfect context for students to practice the literacy skills of reading, writing, and speaking to learn to think critically within a science context, and it should begin in grades as young as Kindergarten. They argue that,

> when literacy is positioned as a tool for investigating phenomena, students learn how to use reading and writing in the same ways that professional scientists do. This approach to instruction provides an opportunity for students not only to build knowledge about the natural world but also to learn about the specialized literacy practices of science. (p. 3)

Additionally, Harman found that "an explicit focus on genre is key at the elementary school level" (as cited by de Oliveira & Lan, 2014, p. 37). While there are many genres of science expository writing (Avalos et al., 2017; de Oliveira & Lan, 2014), the six that are most frequently taught in schools include procedure (how to do something), procedural recounts (how an experiment was performed), explanations (how something works or a process occurs), reports (describing attributes and behaviors of living things) and arguments/expositions (arguing a point of view; Avalos et al., 2017; de Oliveira & Lan, 2014; Fang, 2014). Focusing on a specific genre helps teachers teach science expository writing (de Oliveira & Lan, 2014).

For example, a procedural recount is writing about scientific experiments (de Oliveira & Lan, 2014), which must be done in such a way that the reader can repeat each step of the process. In a case study by de Oliveira and Lan (2014), who studied the impact of genre-based pedagogy by incorporating it into a density unit in science, a teacher taught fourth-grade students to write a procedural recount during a unit on density. The researchers helped the teacher incorporate explicit instruction about procedural recounts. As a result of this instruction, the student in the case study was able to successfully write a procedural recount, including using technical vocabulary and recording events precisely and in the correct order (de Oliveira & Lan, 2014).

Writing within a science context requires an explanation which is a description of how something works or how something happens. Through explanation, students must integrate new knowledge with existing knowledge and use scientific reasoning, resulting in deeper understanding (Chambliss et al., 2003). At the college level, those who wrote explanations reasoned at a higher level and had greater understanding than those who did not (Chambliss et al., 2003). In fact, Rowan (1990) found that college students who wrote higher quality explanations about light refraction scored higher on social cognition, text knowledge, and background knowledge measures than less effective writers. Chambliss and colleagues (2003) built upon Rowan's study and found that as fourth graders wrote explanations, they acquired more complex understandings than they had before the study. The results from these studies show promise for older students learning to write about science, but more research about how to teach young children to write about science is needed.

Using Mentor Texts

Researchers have suggested that one way to support children as they learn to write science expository text is to use mentor texts to model the structure of expository text (Clark & Neal, 2018). Mentor texts demonstrate how to incorporate text structure into writing, effective word choice, varied sentence structure, and how to use charts, graphs, and pictures (Graham, Bolinger, et al., 2012). Teachers are encouraged to begin by modeling how to use a mentor text for students (Moss, 2004b), and students should read mentor texts multiple times while teachers focus students' attention on the particular features (Graham, Bolinger, et al., 2012). Hodges and Matthews (2017) also offered a method for teaching text structures using mentor texts and advised that reading and studying the text structures of mentor texts can help students to learn how to write and establish clear arguments, support their ideas with evidence, and organize their ideas.

Mentor texts “serve as models of how to write well within a genre” (Pytash & Morgan, 2014, p. 95). Using mentor texts during science instruction supports hands-on study of scientific concepts by providing examples and explanations of phenomena students observe, and examples of scientific discourse (Pappas, 2006). Learning this discourse is critical for students to truly learn science (Pappas, 2006). Students must become familiar with science text to be able to communicate in scientific ways (Fang, 2013; Grysko and Zygouris-Coe, 2019; Mantzicopoulos & Patrick, 2011; Wright & Gotwals, 2017b). Mentor texts help students become familiar with how to communicate using science discourse, and mentor texts provide an example of how to structure and organize the information in a science expository text (Fang, 2013; Hodges & Matthews, 2017).

Some studies document the use of mentor texts in teaching expository text structure within the context of science writing. Most of these studies used mentor texts as a pattern for the structure of expository text that students then followed (Bradley & Donovan, 2010; Kersten, 2017; Fang, 2014). For instance, Chambliss et al. (2003) found that when a mentor text was used to teach the characteristics of the explanation genre, most students were able to write their own explanations by correctly using a mentor text as a model. de Oliveira and Lan (2014) similarly found that students could successfully write their own procedural recounts by patterning their writing after the procedural recount text structure used in mentor texts. Additionally, Dollins (2016) found that third-grade students could successfully produce the same type of expository writing techniques learned from mentor texts. Furthermore, Kersten (2017) used mentor texts as informational resources, in addition to teaching structure, and found that students were able to both find information to write about and learn to correctly use text structure in their own writing. Using mentor texts in this manner relates to sociocultural theory in that the mentor texts are serving as the “more knowledgeable other” that assists the learner in the first stage of the zone of proximal development. More research is needed, however, for using mentor text with young children. Furthermore, the researchers in these studies do not indicate how to choose a mentor text in the expository genre for the purpose of teaching writing.

Some researchers have advocated using trade books as mentor texts (Fang, 2013; Moss, 2004a). Trade books allow students to be exposed to expository writing while simultaneously learning about the specific content area (Moss, 2004a). While textbooks are somewhat common in classrooms, they are often outdated and difficult for students to read (Atkinson et al., 2009), and textbooks are not necessarily used in primary grade classrooms. Trade books written on science topics “have the potential to motivate and engage students, broaden and deepen the science curriculum, provide good models of science writing, cultivate scientific habits of mind, challenge and stimulate thinking, and promote inquiry and learning” (Fang, 2013, p. 277), thus making them a good source for mentor text.

Trade books also offer books and texts on a wide variety of subjects (Fang, 2013; Madrazo, 1997), which makes them a good resource for content area studies about specific science topics (Fang, 2013). Moss (2004a) claimed that this variety offered valuable means for capturing students’ curiosity and engaging struggling readers. Indeed, trade books, when compared to textbooks, can better accommodate the differing needs of the students (Fang, 2013; Moss, 2004a). Another benefit to trade books is their portrayal of real-world science practices, particularly for topics that cannot be easily investigated through hands-on experimentation conducted within a classroom (Fang, 2013), such as the effects of volcanic eruption.

Science trade books, however, are not without their drawbacks. There are often many misconceptions in trade books (Rice, 2002). With these fallacies in mind, Fang (2013) said that trade books should be “carefully selected and thoughtfully used” (p. 277). Trade books are a valuable addition to science curriculum, and teachers must learn to select accurate ones (Madrazo, 1997; Rice, 2002; Zygouris-Coe, 2012). To help teachers do this, Atkinson et al. (2009) developed a rubric for evaluating science texts, focusing on both literary quality and scientific accuracy, and Moss (2004b) identified multiple trade book examples that could be used to model each text structure within the science expository text genre. Finding appropriate trade books is important for teachers who want to use them to teach students to use the structure and information found in science expository text.

Teaching Expository Writing Using an Integrated Science and Literacy Approach

Science is a complex discipline with opportunities to use and produce expository text in meaningful, authentic ways (Cervetti et al., 2005; French, 2004). This authenticity happens when the expository text and writing connect to real, hands-on experiences the students have during science (Herrington & Kervin, 2007; Herrington & Oliver, 2000). The ELA-CCSS require that students read and understand challenging texts to help develop necessary problem-solving skills, critical-thinking skills, and analytical skills that lead to future success. Science provides an opportunity for students to explore many different and complex topics and expository texts (Smolkin et al., 2008) and then provides opportunities for students to write about the science concepts they learn. As students do so, they participate within the discipline of science and learn to use the discourse of science in ways that scientists do through the use of reading, writing, speaking, listening, and thinking (Rosebery et al., 1992), which are also social activities necessary within the first stage of the zone of proximal development (see Thompson, 2013). Indeed, Cervetti et al. (2012) reported that students participating in an integrated science and literacy curriculum made gains in content understanding, vocabulary word count, clarity, giving evidence, and writing conclusions. These researchers concluded that science understanding and writing performance were positively associated (Cervetti et al., 2012). Furthermore, writing in science is a particularly mutually beneficial integration, because writing is reciprocal with science (Casteel & Isom, 1994; Patrick et al., 2009; Pearson et al., 2010). Researchers have demonstrated that including writing during instruction improves science learning, and science contexts are ideal for improving writing skills, because the processing skills used for both are very similar (Casteel & Isom, 1994; Pearson et al., 2010).

While there are many approaches to integration, there are three prevailing methods of science and literacy integration methods in the research: Concept-Oriented Reading Instruction (CORI), Guided Inquiry Supporting Multiple Literacies (GIsML), and In-Depth Expanded Application of Science (IDEAS; Pearson et al., 2010).

Concept-Oriented Reading Instruction

Concept-Oriented Reading Instruction (CORI) emphasizes science inquiry, which provides topics that facilitate reading and writing (Ødegaard et al., 2014). The CORI framework consists of four stages: (1) observe and personalize, in which they observe the world around them and decide upon a question to investigate further; (2) search and retrieve, in which teachers show students how to search for information in books to find answers to their questions; (3) comprehend and integrate, in which students gather, understand, and synthesize the information they find; and (4) communicate to others, in which students decide on a way to present the information they learn to others (Guthrie et al., 1994; Guthrie et al., 1996; Guthrie et al., 2000). These stages are based upon seven principles: (1) a conceptual theme chosen by the teacher and (2) real-world interaction, both of which guide the observation in the first stage of the framework; (3) self-direction, such as student choice in questions to research; (4) collaboration, i.e. students working together and giving each other feedback; (5) strategy instruction, including instruction on the writing process; (6) self-expression, such as their choice of presentation method; and (7) coherence, as teachers help students make connections (Guthrie et al., 1998).

There are many positive aspects to CORI. With the exception of one study (Guthrie et al., 1994), ample time is provided for writing (see Guthrie & Alao, 1997; Guthrie et al., 1998; Guthrie et al., 2004; Guthrie et al., 2007) in multiple genres (Guthrie et al., 2000). Students are taught the writing process (Guthrie et al., 1998) and in one study, writing was a specific step in the lesson structure (Guthrie et al., 2007). CORI also emphasizes the use of trade books as a resource for information (Guthrie et al., 1994), and due to its integration of science and literacy, focuses mostly on expository text (Guthrie et al., 2000). Unfortunately, not all CORI studies include an assessment of student writing. Of the CORI studies that did incorporate writing assessments, these researchers examined the student writing for content only. These researchers found gains in how well students included scientific content in their explanations (Guthrie et al., 1996), their improved conceptual knowledge (Guthrie et al., 1998), and their improved comprehension of the topic studied (Guthrie et al., 2004). No other aspects of student writing were considered.

Therefore, CORI seems to be limited when considering the need for solid expository writing instruction. While writing is utilized frequently within the CORI framework, writing is neither the learning goal nor the focus of studies. The goal of CORI is to increase reading motivation (Guthrie & Alao, 1997), and therefore all studies focus primarily on reading motivation and not writing (Ødegaard et al., 2014). While one study claimed students gains on a statewide test in writing, a small number of studies investigate the impact of CORI on informational content within expository writing (Guthrie et al., 1996; Guthrie & Alao, 1997; Guthrie et al., 1998), and none investigate learning expository text structure. Another limitation is that CORI has only been studied in the upper elementary grades (Guthrie et al., 1996; Guthrie et al., 1998; Guthrie et al., 2000; Guthrie et al., 2004). There is no evidence to indicating its effectiveness in Kindergarten through second grade.

Guided Inquiry Supporting Multiple Literacies

Guided Inquiry Supporting Multiple Literacties (GIsML) was a model developed by Palinscar and Magnusson as a research program (Magnusson & Palincsar, 1995; Palinscar et al., 2002). It emphasizes hands-on investigation combined with consulting text to learn from others (Magnusson & Palincsar, 1995; Ødegaard et al., 2014; Palincsar et al., 2002). There are five nonlinear phases to the heuristic for GIsML: engage, investigate, describe relationship, construct an explanation, and report (Magnusson & Palincsar, 1995). The first phase, engage, the teacher decides the general area of inquiry but involves the students in selecting focus questions (Magnusson & Palincsar, 1995). This phase then moves to investigate, in which students do hands-on activities accompanied by research from expository text (Magnusson & Palincsar, 1995). The investigate phase leads to the relationship phase, in which students identify discoveries (Magnusson & Palincsar, 1995). When students enter the construct an explanation phase, they write an explanation in which they describe the why or how of their investigation (Magnusson & Palincsar, 1995). The report phase consists of sharing their learning with others (Magnusson & Palincsar, 1995). The heuristic is nonlinear in that students can move from the relationship phase to either the explanation phase or the report phase, and from the explanation phase back to the investigation phase or on to the report phase (Magnusson & Palincsar, 1995). The report phase cycles back to the engage phase, and the cycle continues (Magnusson & Palincsar, 1995). In other words, students cycle between first-hand investigation (hands-on experimentation) and second-hand investigation (searching literature) to gain scientific understanding (Palincsar et al., 2001).

GIsML is limited when it comes to teaching expository writing. The focus of this integrated approach is on scientific learning. While literacy is used as a tool of investigation and plays a large role in the acquisition of knowledge, much less attention is given to the learning of literacy skills. While teachers teach students to construct scientific explanations, there is no specific writing instruction (Palincsar et al., 2002). Furthermore, studies have narrowed their focus on the upper elementary grades and on students with disabilities (Palincsar et al., 2000; Palincsar et al., 2001), leaving questions about the effectiveness of this instructional method in the primary grades.

In-Depth Expanded Application of Science

Developed by Romance and Vitale (2001) in the early 1990s and studied over a period of five years, the In-Depth Expanded Application of Science (IDEAS) model is a two-hour block of science instruction that incorporates language arts skills. The multi-day IDEAS model is for one unit/concept and includes 11 activity steps: reviewing prior knowledge; concept mapping, in which students fill in a graphic organizer with during whole group discussion; teacher demonstration of an experiment; a hands-on activity, in which students participate in a scientific experiment; continuation of concept mapping; textbook reading for more information; continuation of concept mapping; a writing activity, usually an explanation of the hands-on experiment; an application activity or project; outside reading, meaning additional reading not in the textbook; and a final writing activity, usually a summary (Romance & Vitale, 2001). Individual teachers choose the science concept/unit being explored and the specific activities for each step (Romance & Vitale, 2001).

The results of the five-year empirical study of the IDEAS model's implementation yielded promising results of its effectiveness, with students in the program outperforming students in the control group on reading standardized tests (Romance & Vitale, 2001). However, while the IDEAS model incorporated writing into the activities, writing was not examined as part of the results in the 5-year empirical study nor in subsequent research (Romance & Vitale, 2001; Romance & Vitale, 2008). IDEAS was also not implemented in the lower elementary grades until the 4th year of study (Romance & Vitale, 2001), limiting the results showing its effectiveness in the primary grades. It is clear there are benefits to integrated science and literacy approach, however, research is limited on how these approaches influence student writing.

A New Approach to Teaching Children to Write Science Expository Text

While research indicates that there are many benefits to integrated science and literacy instructional approaches (Guthrie et al., 2007; Magnusson & Palincsar, 1995; Romance & Vitale, 2001), these benefits are predominantly in the areas of enhancing reading ability and the development and construction of science knowledge. To date, the integrated science and literacy instructional approaches are limited because they have not included writing instruction specifically designed for expository texts. Similarly, the literacy-only approaches to writing instruction such as Shared Writing, Interactive Writing, and Writer's Workshop (see Button et al., 1996; Calkins & Ehrenworth, 2016; Hammerberg, 2001) are also limited because they have emphasized teaching children to write narrative text and/or have not accounted for the need to help children develop knowledge on science topics before expecting them to write about these topics. Research is needed that explores how integrated science and literacy instruction combined with a specific writing strategy used to teach children to write expository text is needed.

One writing strategy that might prove helpful in solving this problem is known as the Read-to-Write Strategy that was created by Clark et al. (2013) and evaluated for its efficacy by Clark and Neal (2018). The Read-to-Write Strategy follows a series of steps. First, teachers guide students through the reading of an expository text that serves as a mentor text and one that highlights a particular text structure (Clark et al., 2013; Clark & Neal, 2018). Then, following the pattern presented in the mentor expository text, the teacher guides the students through a series of steps to write their own expository text modeled after the mentor text (Clark et al., 2013; Clark & Neal, 2018). This strategy was found to be effective in teaching children to identify patterns within expository text using a mentor text (Clark & Neal, 2018), but this literacy-only strategy does not allow for the science hands-on experiences and activities that lead to students developing a robust knowledge on the topic. For these reasons, it was determined in the current study to use an integrated science and literacy instruction approach *combined with* the Read-to-Write Strategy (Clark et al., 2013; Clark & Neal, 2018) to teach young children to write science expository text.

Evaluating Student Expository Text Writing

Another pressing concern for teachers and researchers alike is how to evaluate the writing produced by students. A writing rubric is the most frequent form of evaluation in the research studies included in this review of literature. A rubric is a rating scale used to score a student's writing performance (Mertler, 2000). There are two main types of rubrics, a holistic rubric and an analytic rubric. The similarities and differences between these two writing rubrics are discussed next.

Holistic Rubric

A holistic rubric is a rating scale in which all the criteria for the assessment are considered together on a scale of up to 6 levels of performance, with broad descriptions defining each level (DePaul University, 2000). As such, it supports comprehensive judgements of writing quality on a single descriptive scale (Bargainnier, 2003; Mertler, 2000; Moskal, 2000). A holistic rubric typically describes positive elements to be found at each performance level (Becker, 2011; Mertler, 2000). Additionally, a holistic rubric takes little time to score, because a scorer only needs to read the sample once to get an overall impression of the writing (Becker, 2011; Mertler, 2000). A holistic rubric is considered a summative assessment of writing and is particularly useful when it is used to measure mastery after students have had ample time to practice (Mertler, 2000). As a holistic rubric does not provide specific feedback about aspects students can work on (Bargainnier, 2003; Jonsson & Svingby, 2007), it should not be used as students are practicing their writing to avoid punishing students for that practice (Brookhart, 1999; Moskal, 2000).

However, this lack of specificity is one of the limitations of a holistic rubric. Using a holistic rubric to score writing samples does not allow for an examination of specific characteristics unique to expository texts such as the number of signal words students used to indicate the text structure (first, next, then, etc. in sequential text), the technical vocabulary and definitions included by students (e.g., roots, stems, leaves, etc.), the length of student writing as measured by word count, the use of headings by students, and the use of pictures or diagrams.

An analytical rubric has often been used in research and instruction to attend to these limitations of a holistic rubric.

Analytic Rubric

An analytic rubric is a more specific rating scale that incorporates individual scores for each characteristic being measured (Bargainnier, 2003; Mertler, 2000) which results in a more detailed, in-depth score. Using a matrix format, an analytic rubric displays the concept or criteria in the first column and levels of performance in the top row, with detailed explanations within the remaining grid (DePaul University, 2000). It is easily adaptable and can be applied to many types of text (Brookhart, 1999). An analytic rubric is considered a formative assessment and is well suited as a diagnostic tool for classroom teachers trying to identify the strengths and weaknesses of individual students for the purposes of designing interventions and to better meet student needs (Becker, 2011; Jonsson & Svingby, 2007; Wiseman, 2012).

As with any rubric, an analytic rubric also has some limitations. It often takes a greater amount of time to score than a holistic rubric (Jonsson & Svingby, 2007), because the scorer must examine the writing multiple times for each of the characteristics or elements of writing identified in the rubric (Mertler, 2000). Additionally, scoring for one characteristic can influence the scoring of another characteristic by introducing some bias from the scorer (Becker, 2011). For example, a student may spell poorly in their writing which would affect a spelling score, but it may influence the scorer to also give a lower score for clarity of the writing. Furthermore, unless the rubric is well-detailed, interrater reliability can be compromised (DePaul University, 2000). With these strengths and weakness in mind, I examined the studies included in this review of the literature to determine how rubrics have been used in this research. Of the 14 quantitative studies, seven scored writing samples using a holistic rubric, and seven employed student writing using an analytic rubric. These studies are outlined in Appendix A.

Researchers in these studies who chose to use analytic rubrics were interested in the specific ways student writing changed or improved during the course of their study (Bruno, 1983; Clark & Neal, 2018; Cervetti et al., 2012; Guthrie et al., 1996; Troia et al., 2009; Williams, et al., 2005; Yang, 2018), while researchers who chose holistic rubrics were interested in overall quality, overall improvement, or comparative quality of student writing (Avalos et al., 2017; Fang, 2014; Duke & Bennett-Armistead, 2003; Guthrie et al., 1998; Guthrie et al., 2004; Scannella, 1982; Varble, 1990). The age of participants should also be addressed. The participants in Yang's (2018) study included university students and participants in Scannella's (1982) study were high school students. Thus, the rubrics used in the studies that included elementary students as participants (ranging from first to fifth grade) are more meaningful as they reflect writing rubrics that more closely fit the writing abilities of young children. It should also be noted that while some researchers used more than one rubric to measure different elements of the study (Avalos et al., 2017; Troia et al., 2009), none of the studies included both types of rubrics (holistic and analytic). In this review of literature, the benefits and drawbacks of each type of rubric were outlined, but there is no research that has examined how rubric scores compare to one another when both a holistic and an analytic rubric have been used to score the same piece of writing. It would be helpful for teachers to know how these two different types of rubrics compare to one another, and if students tend to score higher/lower based on which rubric is used. Understanding how young children perform using both a holistic and analytic rubric would not only help educators better decide which rubric to use and when, but this research would also add meaningful information to this collection of research.

Need for The Current Study

The research outlined in this literature review indicates that while strides are being made in supporting teachers as they teach students to write expository text, there is room for improvement – especially in the primary grades. To date, writing instruction approaches that focus primarily on teaching children to write narrative texts or do not allow for students to experience firsthand the science experiences and experiments that can help students develop content understanding before writing expository text are limited. Conversely, existing approaches that integrate science and literacy have failed to give adequate attention to writing instruction for science expository text specifically. For these purposes, a combination of instructional approaches was employed in the current study to fill these gaps in the research.

I hypothesized that an integrated science and literacy approach that included hands-on science exploration *combined with* the Read-to-Write Strategy (see Clark et al., 2018; Clark & Neal, 2013) would produce statistically significant higher rubric scores examining the expository texts written by second-grade students after the instruction had been completed. This was hypothesized due to the personal experiences with science that students had, time to develop and construct knowledge on a given science topic, and because of the scaffolding, mentoring, and social interactions that took place with the teacher and peers in the classroom. I also hypothesized that students would demonstrate growth in their writing regardless of the writing rubric used. It was anticipated, however, that the analytic rubric would provide more detailed information about any growth or areas of need in student writing based on the detailed nature of this rubric, and as a result, students will demonstrate less growth on the analytic rubric when compared to the holistic rubric.

CHAPTER 3

Method

The purpose of this study was two-fold. The first was to determine how an integrated literacy and science instructional approach designed to teach second-grade students to write science expository text combined with the Read-to-Write Strategy (Clark et al., 2013; Clark & Neal, 2018) influenced the students' science expository writing. This was determined by comparing analytic and holistic rubric scores on student writing samples before and then after the instruction was provided. Improvement in rubric scores was interpreted as a reflection of student writing growth and ability in the following specific areas: expository text structure, inclusion of science content, length of text, and writing conventions and mechanics. The second purpose was to determine if there were any variations in scores depending on whether the holistic or analytic rubric was used to evaluate the student writing samples. In this chapter, I present the method that was used to conduct this quantitative study including a description of the research design, setting, participants, measures, procedures, and the data collection and analysis procedures.

Research Design

This study employed a pre/posttest research design (Creswell & Guetterman, 2019). Because of the quasi-experimental nature of this study, the researcher was not be able to control for selection (choosing certain participants) or mortality (participants who begin but do not complete the study) (Creswell & Guetterman, 2019). The effects of these threats to internal validity were minimized by having a large enough sample size to account for these variations in participants (Creswell & Guetterman, 2019). Other threats to internal validity have also been identified and addressed. History was attended to by having the study take place in a timely manner (Creswell & Guetterman, 2019). Maturation was also considered by ensuring that all the participants were in the same grade level and are receiving instruction at the same pace (Creswell & Guetterman, 2019). Regression was avoided by conducting the study in a school that typically earned average reading scores (Creswell & Guetterman, 2019). Additionally, the halo effect was avoided by keeping student identity confidential (Nicolau et al., 2020). Furthermore, students were assured that the teachers simply wanted to see what they could write, therefore removing performance anxiety and avoiding the Hawthorne effect (Sackett Catalogue of Bias Collaboration et al., 2017).

The independent variable in this study, or the variable introduced to examine its influence on the expository writing of second graders, was the integrated science and literacy instruction combined with the Read-to-Write Strategy (Clark et al., 2013; Clark & Neal, 2018). The dependent variable was the rubric score that each student received on their two expository text writing samples (pre- and post-instruction writing samples).

Setting

Permission to complete this study was obtained from Mountain Crest School District (all names are pseudonyms) and the principal and second-grade teachers at Pine Hollow Elementary School. Approval from the Institutional Review Board (IRB) was also secured (see Appendix B for all IRB materials and parent permission/assent forms). Consent forms were provided in both English and Spanish. Consent forms were signed by parents and assent forms were signed by students and returned before any data collection was initiated.

The study took place in a Title I public elementary school located in a suburban neighborhood near a university. The school served 710 students in grades Pre-K to 6th grade. Fifty-two percent of the students were male and 48% were female. Forty percent of the students at this school qualified for free or reduced school lunch. Twenty-seven percent of the students were Hispanic, 2% were Hawaiian, 67% were White, and 4% identified as being multi-racial.

Participants

Participants included 71 second-grade students from three self-contained classrooms who were invited to take part in this study. Of these students, 49% of the participants were male and 51% were female students, and all second-grade participants ranged in age from 7- to 8-years old. Although the school was not comfortable with providing information about any students who might be receiving special services, state assessment data indicated that the school's overall testing rank in reading was in the lower 50% of elementary schools in the state, and 41% of the students were proficient in reading.

The second-grade teachers who agreed to participate in the study were recruited based on their reputation for their interest in teaching science and were recommended by science education professors from a local university. All these teachers were White and female. Teacher A had 30 years of teaching experience, Teacher B had five years, and Teacher C had three years. Each teacher was provided with all the instructional materials necessary to teach the lessons, and a one-day training on how to teach using the integrated science and literacy instruction was provided to the teachers. At the end of the study, each teacher received a gift card for their participation.

Measures

In order to determine if there were any differences in the students' ability to write science expository text before and after the instruction that was specifically designed for this study, a pre- and post-instruction writing sample was collected just before and immediately following the instruction. The integrated science and literacy instruction portion of the study was designed by a group of science and literacy educators and researchers and was piloted in previous studies (see Clark et al., 2020), and was used along with the Read-to-Write Strategy (Clark et al., 2013; Clark & Neal, 2018). The writing samples were evaluated using two writing rubrics, namely a holistic and an analytic writing rubric. Using a holistic rubric provided an over-arching perspective of how the integrated science and literacy curriculum influenced students' science expository writing, while an analytic rubric indicated how well students performed based on the specific elements identified in the analytic rubric.

Holistic Rubric

The holistic rubric used in the current study is the Informative Writing Rubric: 2nd Grade (Appendix C). This rubric was created by the State Board of Education, is currently used to score state writing assessments for students in second grade and aligns with the informative/explanative writing standard outlined in the ELA-CCSS. This rubric provides an overall assessment of two separate and important components of writing. The first area of the rubric examines the Statement of Purpose/Focus and Organization within each writing sample and is worth 4 points (67% of the total points). High scores for Statement of Purpose/Focus and Organization include a strong, clear introduction, at least 3 facts about the topic, and a concluding statement or sentence that provides a summary of those facts. Research supports the need for expository writing to have a well-organized structure (Read et al., 2008). Focus indicates that the writing produced by students stayed focused on the assigned science topic and is evidenced in student writing by the facts shared by each student. In the current study the writing prompt "What is the life cycle of a plant?" was used. This prompt was similar to the writing prompt used in state writing assessments for expository text and aligns with the science curriculum standards being taught in these second-grade classrooms.

The second area measured by this holistic rubric is the Conventions/Editing that each student used in his/her writing sample. Students can earn up to 2 points for their use of Conventions/Editing (33% of the total points), thus weighting Conventions/Editing less than Statement of Purpose/Focus and Organization. High scores for Conventions/Editing demonstrate appropriate use of capitalization, spelling, punctuation, use of simple and compound sentences with only minor errors that do not obscure meaning (e.g., infrequent misspellings, punctuation errors, or capitalization errors that do not change the meaning of a sentence). Teaching students to incorporate these writing conventions is important as researchers have noted how students who fail to grasp these writing conventions struggle to learn to write effectively (Berninger et al., 2002). Writing convention errors create “visible indicators of written text quality” (Daffern et al., 2017, p. 77). Therefore, it is appropriate to include writing conventions in the scoring of expository text. The intent of the holistic rubric is to combine the Statement of Purpose/Focus and Organization scores and the Conventions/Editing score to produce one overall writing score.

Analytic Rubric

The second rubric, an analytic rubric, is found in Appendix D. I created this rubric using the rubric creation process and the model for analytic rubrics outlined by Mertler (2000). It was not tested prior to this study as it was created specifically for this study and is an example of a teacher-created rubric like those used by teachers across the U.S. However, reliability for this rubric was attended to through the use of Cohen’s Kappa (see section on Data Collection and Analysis) to ensure inter-rater reliability. The purpose of ensuring inter-rater reliability is to provide evidence that the rubric is reliable no matter who is using it. Content validity was also addressed by ensuring the analytic rubric aligned closely with the ELA-CCSS, the grade level science standards, and previous research.

When creating the rubric, I first considered the specific writing standard for informative/explanatory text as listed in the ELA-CCSS for second-grade students, the state science standards, and characteristics unique to sequential science expository text. The state where the current study took place had not yet adopted the Next Generation Science Standards, therefore the state's current science standard was used. Table 1 provides information about how each rubric element aligned with and addressed each of the curriculum standards for both the literacy and science content to attend to content validity of the writing rubrics.

Table 1

Alignment with Curriculum Standards and Writing Rubric

Standard	Description	What is Measured	Type of Rubric
ELA-CCSS W.2.2	Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points, and provide a concluding statement or section.	Structure	Holistic or Analytic
ELA-CCSS W.2.8	Recall information from experiences or gather information from provided sources to answer a question.	Content	Holistic or Analytic
ELA-CCSS L.2.1.F	Demonstrate command of the conventions of English grammar and usage while speaking or writing: Produce complete simple and compound sentences.	Conventions	Holistic
ELA-CCSS L.2.2	Demonstrate command of the standard English capitalization, punctuation, and spelling when writing.	Conventions	Holistic or Analytic
State Life Sciences Standard	Describe and model life cycles of living things (Plant Life Cycle)	Content	Analytic

In addition to aligning the analytic writing rubric with the literacy and science standards for second grade, I also relied on previous research to identify other specific areas to examine within student writing samples using the analytic rubric. The first three standards-based elements included on the rubric are topic introduction, steps of the plant life cycle, and concluding statement. These elements comprise ELA-CCSS standard L.2.2 (see Table 1), and previous research also supports their inclusion (see Clark & Neal, 2018; Fitzgerald & Shanahan, 2000). In an interview with author Melissa Stewart (see Young, 2017), she defined expository text as a form of nonfiction text that "explains, describes, and informs in a clear, accessible fashion" (p. 31). Thus, it was also necessary to evaluate the science content that students provided in their expository texts. In this study, the science topic was the life cycle of plants. Furthermore, Fitzgerald and Shanahan (2000) defined domain knowledge about content as one of the categories of knowledge used by writers. Their list, called the "Categories of Knowledge That Readers and Writers Use" (Fitzgerald & Shanahan, 2000, p. 41) also includes many of the other criterion included in the analytic rubric (see Appendix C). One such category is text structure, which encompasses topic introduction, steps of the plant life cycle, and concluding statement. Topic introduction and conclusion were also included on the rubric in Clark and Neal's (2018) study of second-grade students' sequential writing.

The next rubric element that was included was signal words, and signal words also related to the text organization or the text structure used within the text (see Fitzgerald & Shanahan, 2000). In this study, the science topic was the life cycles of plants, and therefore the expository text structure was identified as the sequential text structure. Researchers have recommended counting the use of signal words to indicate an understanding of the sequential text structure (Clark & Neal, 2018; Hall-Kenyon & Black, 2010)

Additionally, the ELA-CCSS place a heavy emphasis on the writing conventions including capitalization, punctuation and spelling. Such skills are critical for text generation (see Fitzgerald & Shanahan, 2000), and Furey et al. (2017) found that conventions could be improved with writing instruction. For these reasons, these elements were also included in the analytic rubric as categorized by the ELA-CCSS as capitalization, punctuation, and spelling in ELA-CCSS L.2.2 (see Table 1).

Word count was also included on the analytic rubric. Some researchers have determined that the length of student writing (as measured by word count) can indicate writing quality (Clark & Neal, 2018; Lienemann et al., 2006; Morphy & Graham, 2012; Purcell-Gates et al., 2007). More specifically, researchers have found that the longer a student's writing sample is, the more likely the writing will be of higher quality (Lienemann et al., 2006). This is especially true in the writing produced by young children. As students age, they are able to produce writing samples of shorter lengths that are evaluated to be of higher quality writing due to the fact that as students gain experience with writing, they also learn to be succinct in their explanations (Festas et al., 2015).

Once the rubric elements were determined, the amount of points each rubric element would be worth was determined as suggested by Mertler (2000). A five-point rating scale of four to zero was utilized with four being the highest score, and zero representing the lowest score. In an analytic rubric, higher scores are usually listed first. Moreover, a description of what the expectations were for each rubric element at each point level was also outlined (see Mertler, 2000), and examples, if necessary, were also included.

As recommended in previous research, each rubric element was weighted to emphasize some elements of student writing over other elements based on their importance in relation to the writing task at hand and the attention each element received during instruction (Clark & Neal, 2018; Dickinson & Adams, 2017; Pate et al., 1993; Wolf & Stevens, 2007). The combination of these weighted scores became the overall total rubric score. The first four elements of the rubric (topic introduction, steps of the plant life cycle, concluding statement, and signal words) were weighted the heaviest because they received the most emphasis during the instruction. Of these, the rubric element related to students being able to list the steps of the plant life cycle was emphasized the heaviest with a weight of 30%. This was because this rubric element measured two standards—a portion of the informative/explanatory standard from the ELA-CCSS (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) and the state science standard. Second, the use of signal words was weighted fairly high at 20% because these words indicated that students were using the sequential text structure when they wrote about the plant life cycle. Finally, the topic introduction and concluding statement were each weighted at 15% because the ELA-CCSS requires that students include these elements when writing expository texts.

The remaining four rubric elements were each weighted at 5%. These elements included capitalization, ending punctuation, spelling, and word count. Capitalization, ending punctuation, and spelling were included because they were considered important writing practices (see Graham, Bolinger et al., 2012), were required by ELA-CCSS, were modeled in the mentor texts, and have been measured in other research that has explored student writing of expository text (see Clark & Neal, 2018). However, these rubric elements were weighted lower than other rubric elements because they were not as heavily emphasized in the instruction. Finally, word count was also weighted at 5%. Word count was included as a rubric element because it has been identified as an indicator of writing quality in previous research (see Lienemann et al., 2006; Morphy & Graham, 2012; Purcell-Gates et al., 2007). Word count was also weighted only at 5% because it was not heavily emphasized in the instruction.

The process of creating and refining the analytic rubric was an iterative process. Throughout the course of developing, creating, and editing the rubric, there were 11 iterations. The original rubric was created using ELA-CCSS, state science standards, and previous research to refine and increase clarity when using the analytic rubric to score student writing. My thesis advisor and I scored several samples after each iteration. When we had questions or encountered difficulty in deciding on a score, it was an indication that there was a need for more editing and tweaking of the wording used within the rubric. We met frequently to compare scores on individual rubric elements as well as the rubric as a whole. After scoring student writing using the rubric separately and independently, we came together to discuss discrepancies and possible interpretations scorers might have while using the rubric. The goal was to refine the rubric so that it was concise and clear enough for anyone to score the student writing samples using the rubric in a reliable manner. The structure of the rubric was originally a matrix only, as suggested by Mertler (2000), but was later changed to the structure used by Clark and Neal (2018) so as to make scoring with a weighted rubric easier.

Additionally, there were other changes made over the course of several iterations. For example, the descriptions for the capitalization and punctuation rubric elements were edited and revised many times. Errors made by students in relation to capitalization and punctuation were originally counted in early drafts of the rubric. However, this required the need to interpret run-on sentences, leaving a scorer to make judgments about what students meant in their writing, which made the rubric more subjective and open to interpretation. To attend to the goal of clarity, capitalization and punctuation were eventually revised to count only correct instances of punctuation being used by the students, thus eliminating the need for interpretation. As another example, minor revisions were also made to the number spreads (0-4) for the spelling and word count rubric elements in an attempt to identify the correct range and expectations that were appropriate for second-grade writers.

Other elements were originally included but were eventually excluded from the rubric. One example of this is the rubric element that measured the science technical vocabulary used by students. It was originally included as a part of the steps of the plant life cycle rubric element, but its inclusion made scoring cumbersome. For example, a student could accurately describe what happens in the life cycle of a plant but use broad descriptions instead of science specific vocabulary words which led to a lower score even though the student could effectively describe the plant life cycle. Creating a separate rubric element to examine vocabulary words specifically was also considered, but that would have the unintended result of redundancy as it would reward those who used vocabulary twice for content, while punishing those who did not use specific science vocabulary. We determined that students could demonstrate content knowledge without the use of specific vocabulary words or technical vocabulary and so this separate rubric element was ultimately excluded.

Another element excluded from the rubric was the use of simple and compound sentences because it also posed trouble for scoring. Many of the second-grade students wrote run-on sentences. This again required the scorer to make judgements about when sentences should be counted as simple sentences with mistakes in capitalization and punctuation or the use of compound sentences with mistakes in conjunctions. Both options made the scoring subjective and unclear. Therefore, in later drafts of the analytic rubric, the simple and compound sentences rubric element was revised to include only subject-verb agreement as required by ELA-CCSS L.1.1 (see National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). However, this also led to scoring difficulty. In the event a scorer encountered a run-on or compound sentence with several instances of subject-verb agreement, the scorer had to decide whether each instance be considered separately or the sentence be considered as a whole. The difficulty in making the distinction clear on the rubric led to the decision to not include it in the analytic rubric in the current study. This decision was also made because teaching the students about simple and compound sentences was not emphasized in the instruction.

Procedures

Each teacher was provided with the daily lesson plans and all materials needed to teach the science and literacy integrated instruction except for writing utensils, paper and Chromebooks, which were provided by the school. Additionally, teacher observations were conducted to ensure fidelity to the instruction. See Appendix E for the teaching observation form. In order to teach children to write expository text, it is important that the teacher considers which text structure to use or to emphasize first when working with young children (Moss, 2004b). Moss (2004b) suggested that teachers teach the sequential or compare and contrast text structures first, as these seem to be easier for young children to discern and recognize within writing, therefore, students in the current study learned to write using the sequential text structure for their expository writing. The topic was on the life cycle of plants as it aligned with the state science standards for second grade. Signal words associated with the sequential text structure include some of the following: first, afterwards, finally, next, and following.

Collection of the Pre-Instruction and Post-Instruction Writing Samples

The pre-instruction writing sample was collected the day before instruction began. The post-instruction writing sample was collected the day after the instruction ended. To collect the writing samples, teachers passed out a piece of lined paper and asked the students to write an answer to the following question: What is the life cycle of a plant? Teachers did not help students with anything including the content, spelling, grammar, editing, or conventions, but teachers were told to encourage students to do their best. Students were allowed 30 minutes to complete the writing task. The second-grade teachers determined the amount of time they felt students would need to complete the task, but most students completed the pre-instruction writing sample in 15-20 minutes. During the collection of the post-instruction writing sample, the same procedures were followed, and most students took 20-30 minutes to complete the writing task.

Instructional Procedures

Data collection and instruction for the current study took place over the course of 10 days. The teachers designated three days per week for the instruction, with each daily session lasting approximately 30 minutes. This teaching schedule resembled the amount of time these teachers usually spent on writing or science units during their regular instruction. For reference, writing was typically taught every few weeks, as the teachers alternated between teaching science, social studies, and writing in the afternoons. However, during the course of the current study, the teachers refrained from teaching any additional writing instruction.

The integrated science and literacy instruction consisted of hands-on science experiences and activities combined with the Read-to-Write Strategy (Clark et al., 2013; Clark & Neal, 2018). The Read-to-Write Strategy was chosen as the writing instruction strategy to combine within the integrated science and literacy curriculum, because research has determined it is an effective strategy for teaching expository text structure (Clark et al., 2013). As the Next Generation Science Standards (NGSS) did not go into effect in the state where the study was conducted until the 2020-2021 school year, the content for the science instruction in the current study was based on the current state science standards.

The pre-instruction writing samples were collected on day one. Instruction began on day two, the day after the pre-instruction writing samples were collected, and continued through day nine. These lessons occurred three days a week and during a time that was separate from the student's official block of literacy instruction; most of these lessons occurred in the afternoon. The post-instruction writing sample was collected on day ten, the day after the final day of instruction. The daily instruction and procedures for learning activities are described in Appendix F, the instructional materials used for the instruction are found in Appendix G, and the children's literature used as mentor text is listed in the Children's Literature section of the References. The instruction was specifically designed to fill two gaps in the research literature. One gap is when teachers use literacy-only writing instructional approaches to teach writing which do not allow for students to develop their content knowledge before writing. The second gap is that most integrated science and literacy instructional approaches have largely ignored intentional writing instruction. The integrated science and literacy instruction combined with the Read-to-Write Strategy (Clark et al., 2013; Clark & Neal, 2018) in the current study was designed to teach children to write expository text.

Days two through seven of the instruction focused on helping the second graders to build and develop their background knowledge about the life cycle of a plant so they were enabled to write on this topic. These activities included hands-on science activities and observations, growing an actual seed and documenting its growth, and watching videos and other media to gather more information. Trade books were also used during science experiences and activities to support students as they developed their understanding about the life cycle of plants to support students as they constructed their knowledge.

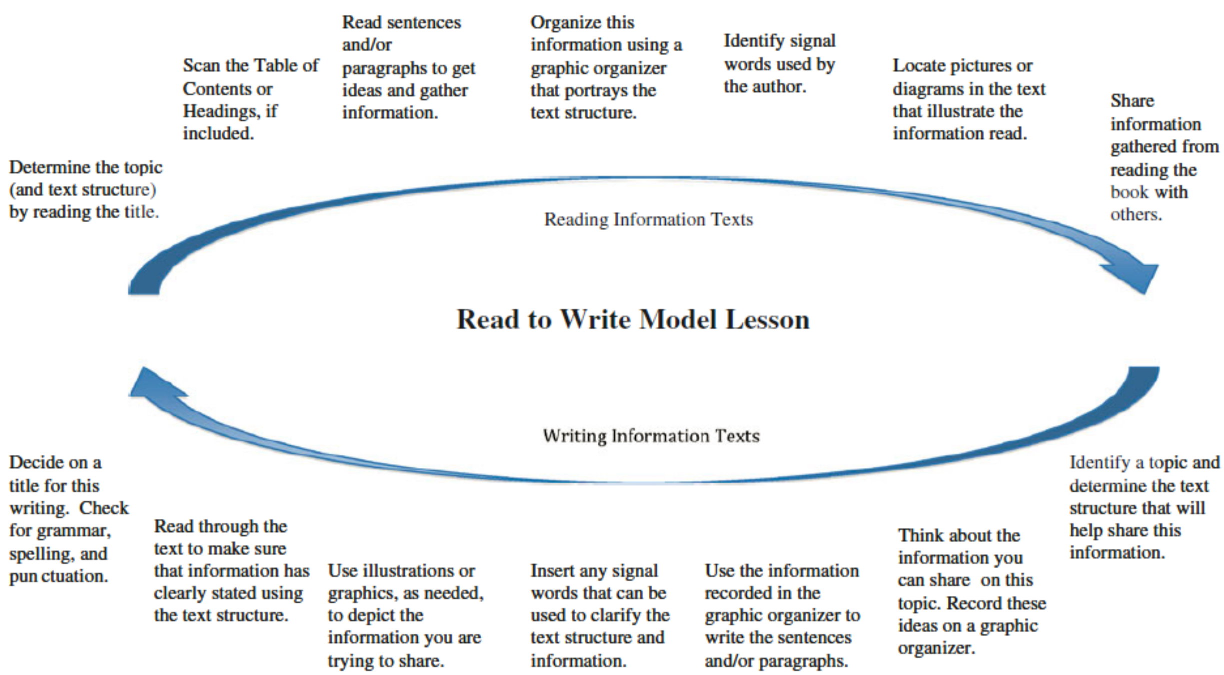
On day nine, students were introduced to the Read-to-Write Strategy (see Figure 1) designed specifically for teaching students to write expository text using mentor text (Clark et al., 2013). The life cycle of a plant indicated that students needed to be taught how to use the sequential text structure, which included teaching them the signal words associated with sequential text. Therefore, expository texts that model this text structure were used. For this part of the instruction, the teacher read aloud a mentor expository text while also calling attention to the various aspects of the book (title, table of contents, headings, information and definitions, signal words, pictures, and diagrams). Next, the teacher guided the students to enter this information into a graphic organizer and encouraged students to share their learning with one another. This completed the first 7 steps of the Read-to-Write Strategy.

Together, the class then completed the next seven steps of the Read-to-Write Strategy as they practiced writing a sequential expository text together, carefully attending to sharing correct information, using signal words, and checking writing conventions. Note that the sequential text the class wrote with and alongside their teacher was about the life cycle of a chicken and the information was developed from the mentor text. This was intentional so the teacher could model how to write science sequential text, but not on the topic of the life cycle of plants being studied. This was to prepare students to write their own sequential science informative/explanatory text on the life cycle of plants.

Ideas and concepts stemming from the sociocultural theory were used to create the instruction. As previously detailed in the theoretical framework of the current study, the sociocultural theory suggests that children actively construct knowledge as they interact socially with others, have experiences, and begin to assign meaning to the ideas and concepts they are learning about (Vanderburg, 2006). Therefore, the instruction within the current study was designed to provide opportunities for students to actively observe, record, and discuss live plants and seeds to help students develop an understanding of what plants are and how they grow.

Figure 1

Read-to-Write Strategy from Clark et al. (2013)



Many researchers have also supported the idea that social interaction such as this is key to helping young learners during the first stage of the zone of proximal development (Bodrova & Leong, 1998; Everson, 1991; Nordlof, 2014; Nurfaidah, 2018; Thompson, 2013), so instruction was designed to have students work collaboratively as a class or in small groups on each day of instruction. The instruction was also tied to the social context of reading, writing, speaking, and listening (Emig, 1977; Thompson, 2013), and a sample of these activities from the instruction are presented in Table 2.

Table 2

Sample Activities Used to Teach Sequential Expository Text

Day	Reading	Writing	Speaking	Listening
4	Small groups are assigned a plant part. In small groups, students read digital books about their assigned part on Epic!	Students take notes on Handout 3: *Parts of a Plant* while they are reading and while groups are presenting about their parts. Students observe their bean seed and add sketch and notes in next block of their *Seed Diary*.	Each group reports on their plant part to the class.	Students listen to each group report about their plant parts to learn about the parts they did not study.
5	In small groups, students read one of two books about pumpkin plants.	In small groups, students take notes on sticky notes to record what they learn while reading. Students observe their bean seed and add sketch and notes in next block of their *Seed Diary*.	Each small group shares their findings with the class.	Students listen to one another sharing findings. Students watch a time-lapse video of a pumpkin seed growing.
6	In pairs, students read digital books on plant life cycles on Epic!	Students take notes on Handout 4: *From Seed to Plant* to record what they learn while reading. Students observe their bean seed and add sketch and notes in next block of their *Seed Diary*.	Each pair shares their findings with the class.	Teacher shows two videos about plant life cycles. Students listen to one another during a class discussion of the videos. Students listen to one another as each group shares their findings from the reading.

Additionally, the first stage of the zone of proximal development requires a "more knowledgeable other" (Everson, 1991; Gallimore & Tharp, 1990; Nurfaidah, 2018; Vygotsky, 1978), and in the instruction the teachers, other students, videos, and texts served in the role of "more knowledgeable other" to scaffold student learning and construction of knowledge. The positioning of the Read-to-Write Strategy (Clark et al., 2013; Clark & Neal, 2018) was also intended to be a scaffold during the first stage of the zone of proximal development, and prepared students by supporting them through the process and modeling of how to write a science expository text so that on day 10, students could move to the second stage of the zone of proximal development and write their science expository text independently.

Furthermore, the sociocultural theory describes tools within an environment that help students grow within the zone of proximal development (Bomer, 2003; Thompson, 2013; Wertsch, 1993), and the tools used for data collection and instruction included the mentor texts, the digital texts on the website entitled Epic!, YouTube videos, Chromebooks, the papers/pencils and other writing instruments, the plants, seeds, and materials to conduct experiments. Finally, as the trade books used in the instruction were intended to be a scaffold for learning, they were reviewed for accuracy and literary quality before in the instruction as suggested by Atkinson et al. (2009). Each book was checked for criteria such as accuracy of science content, clear sequence of ideas, reading level, and organization (see Atkinson et al., 2009).

Data Collection and Analysis

Data was collected from each participant during the administration of both the pre-instruction writing sample and the post-instruction writing sample. These writing samples were scored using the holistic rubric (see Appendix C) and the analytic rubric (Appendix D). Cooper and Odell (1977) emphasized that reliability depended on more than one writing sample from more than one timepoint being scored by more than one individual. Therefore, both pre- and post-instruction writing samples were blindly scored by two individuals using the holistic rubric, and then the analytic rubric. To ensure interrater reliability, or the agreement among the two raters, Cohen's kappa was employed to ensure there was a 70% or higher interrater reliability among the two raters (McHugh, 2012). Cohen's kappa was used because it provides a measure of overall agreement between the raters while taking chance agreement into consideration (Kvålseth, 1989). The results of the Cohen's kappa are reported in the Results section.

Data Analysis for Research Question One

After the pre- and post-instruction rubric scores are determined, the rubric scores were entered into SPSS version 25 and analyzed using two different statistical tests. A Wilcoxon signed-rank nonparametric test was used to analyze each of the two elements of the holistic rubric. A Wilcoxon signed-rank nonparametric test was also used to analyze the individual rubric element scores from the analytic rubric. A Wilcoxon signed-rank test was necessary because the rubric scores were ordinal data, and ordinal data must be examined using a nonparametric test (Kuzon et al., 1996; Stevens, 1946). In this case, the ordinal data was ranked data and therefore cannot be described using means or standard deviations, as is typically provided with parametric tests, such as with a *t* test (Kuzon et al., 1996). Therefore, for the Wilcoxon signed-rank test, the median was used to describe the descriptive statistics for the ordinal data. Moreover, a *t* test would be inappropriate for analyzing these data for each of the analytic rubric elements because the more *t* tests that are conducted increases the likelihood of committing a Type I error (Sato, 1996), which is where the researcher rejects a true null hypothesis.

Using a Wilcoxon signed-rank test requires that the researcher attends to three assumptions. First, the dependent variable must be ordinal. Second, the independent variable must consist of related groups. These first two assumptions were considered prior to any data analysis. The test scores were ordinal data, and the groups consisted of the same participants producing both the pre-and post-instruction writing samples, so neither of these assumptions were violated. Next, the third assumption when using the Wilcoxon signed-rank test is that the distribution of the differences between the related groups must be symmetrical ("Wilcoxon

Signed-rank Test Using SPSS Statistics," 2018). This was explored by creating a histogram of the data before running the Wilcoxon signed-rank test. If the distribution of the differences was not symmetrical, the assumption was considered violated. The data would then need to be transformed before running the test ("Wilcoxon Signed-rank Test Using SPSS Statistics," 2018).

Once the scores for each individual rubric were calculated, an overall rubric score was determined. At this point, the overall rubric scores were continuous data and so a parametric test could then be used. A paired-samples *t* test was used to compare the overall total rubric scores for each rubric to determine if there were any statistically significant differences in mean scores (Xu et al., 2017) from pre- to post-instruction. There are four assumptions for a paired-samples *t* test that must be considered. First, the dependent variable must be continuous. Second, the independent variable must be related groups. Third, there should be no significant outliers, which would skew the data. Fourth, the data should be normally distributed.

Statistical significance for all tests was set at .05. Finally, an effect size for the *t* tests was determined using a Cohen's d effect size measure. An effect size is used by researchers to determine the magnitude and the strength of the effect (Graham & Perin, 2007). Cohen (1988) suggested the following interpretation for effect sizes to be small ($d = 0.2$), medium ($d = 0.5$), and large ($d = 0.8$).

Data Analysis for Research Question Two

The use of the Wilcoxon signed-rank test was also allowed for a comparison between how students performed when the writing samples were scored using the analytic and holistic rubric. The output generated from the Wilcoxon signed-rank test in SPSS provided the negative ranks, positive ranks, and ties between the rubric scores from the pre- and post-instruction writing samples. This allowed for a comparison to see how many students scored higher, lower, and the same on the post-instruction writing samples when compared to the pre-instruction writing samples when the analytic and holistic rubric were used.

CHAPTER 4

Results

Chapter one outlined the struggle some students have learning to write as well as the struggle many educators have in finding appropriate writing instruction. The ELA-CCSS require that students write earlier in their education and learn three types of writing: narrative, argumentative, and expository (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Even so, little attention has been given to helping educators teach children to write expository text (Clark et al., 2013), especially in the primary grades. While several traditional and integrated instructional methods have been used to teach expository writing, there is a dearth of instructional methods for teaching expository text that allow for both the development of content knowledge necessary to write about a particular subject and specific expository text writing instruction.

One possible solution is the development of an instructional method that combines an integrated science and literacy instruction with specific expository text writing instruction. This study was designed to observe the effect of this type of instructional method. The instructional method was designed to teach students science content and how to write sequential expository text through an integrated science and literacy curriculum that teaches the life cycle of plants through the use of mentor texts and hands-on science experiences, combined with expository writing instruction to assist students in writing about what they are learning. The first research question in this study investigated the effect of this instruction on student writing. The second research question investigated how writing rubric scores varied when using two different rubrics (holistic and analytic). The findings used to answer these research questions are presented in this chapter.

In this study, 71 second-grade student participants received the instruction. Each participant wrote a pre-instruction and a post-instruction writing sample. Data from each sample was analyzed using a holistic rubric (see Appendix C) on two elements of writing: the statement of purpose/focus and organization which covered introduction, facts about the topic, and conclusion, and conventions/editing which covered sentence structure and spelling. Each sample was also examined and scored with a weighted analytic rubric (see Appendix D) on eight elements of writing: the quality of topic introduction, number of steps of the plant life cycle included, the quality of concluding statement, the amount of different signal words used, the number of sentences properly capitalized, the number of sentences ending with appropriate punctuation, correct spelling, and the number of words written. The scores from both rubrics were each recorded in a spreadsheet (see Appendix H).

In order to answer research question one, scores from the pre- and post-instruction writing samples were first analyzed using descriptive statistics and then using inferential statistics. Because the scores for each individual element of the holistic and analytic rubrics were ordinal data, inferential statistics were produced using a Wilcoxon signed-rank test. Next, the total holistic rubric scores and the total weighted scores for the analytic rubric were each analyzed using paired-samples t tests to determine if there were any differences between pre- and post-instruction writing samples. For research question two, I used the data from the Wilcoxon signed-rank test that was conducted for the total holistic rubric scores and the total weighted analytic rubric scores in order to examine how many students improved their score, maintained their score, or had a lower score on the post-instruction writing samples. This was done to determine the performance of students based on the rubric that was used.

This chapter is divided into two sections, one for each research question. For research question one, the results of the Wilcoxon signed-rank test analysis for each of the two holistic rubric elements are presented, followed by the results from the paired-samples *t* test analysis of the total scores of the holistic rubric. Next, the results of the Cohen's Kappa test for inter-rater reliability for the analytic rubric are presented. Subsequently, the analysis from the Wilcoxon signed-rank test examining each of the eight writing elements that comprise the weighted analytic rubric is outlined. This is followed by the results of the paired-samples *t* test using the total overall scores of the weighted analytic rubric. For research question two, the results of the Wilcoxon signed-rank test analysis that allowed for a comparison of scores from both rubrics.

Research Question One

Research question one was, "How does an integrated science and literacy instructional approach combined with a writing instructional strategy designed specifically for teaching expository text influence the science expository text written by second-grade students?" The results for the statistical analysis for this question is presented in five sections. First, the findings from the two individual holistic rubric elements are shared. Second, the results of the total holistic scores are presented. Third, the analysis on the inter-rater agreement for the analytic rubric is presented. Fourth, the findings from the individual analytic rubric elements are shown. Finally, the results of the analysis of the total weighted analytic rubric scores are shared.

Findings from the Two Individual Holistic Rubric Elements

The holistic rubric examined a student's ability to include a statement of purpose, to focus and organize writing, and to attend to conventions and editing in writing. This section reports on how students performed on these two rubric elements of the holistic rubric. Using descriptive and inferential statistics, the frequency scores, ranks, median scores, *z* scores, and p-values from the Wilcoxon signed-rank test results are shared.

Statement of Purpose/Focus and Organization. The first element of the holistic rubric was the statement of purpose/focus and organization. The assumptions for a Wilcoxon signed-rank test were checked first. The first assumption was that the data must be ordinal. The second assumption is that the comparison must be between two related groups. These first two assumptions were met because the rubric scores were ordinal data and the same group of participants provided the pre-instruction and post-instruction writing samples. The third assumption is that the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. A histogram was created to check this assumption, and the distribution was found to be roughly symmetrical. Once it was determined that these assumptions were met, a Wilcoxon signed-rank test was then performed. The frequency and the range of scores for the inclusion of statement of purpose/focus and organization in writing for the pre- and post-instruction writing samples are shown in Figure 2.

Descriptive Statistics. The range of scores was 0-3 with a possible range from 0-4 for the pre-instruction writing samples, while the range of scores for the post-instruction writing samples was 0-4. Thus, the range of scores was greater for the post-instruction writing samples than the range of scores reported from the pre-instruction writing samples. The median scores and the percentile scores are listed in Table 3. Of the 71 participants in the study, 41 students demonstrated improvement on the statement of purpose/focus and organization rubric element in the post-instruction writing samples compared to the pre-instruction writing samples, whereas 22 participants saw no improvement and eight participants reported lower scores from pre- to post-instruction.

Figure 2

Frequency Scores for Statement of Purpose/Focus and Organization

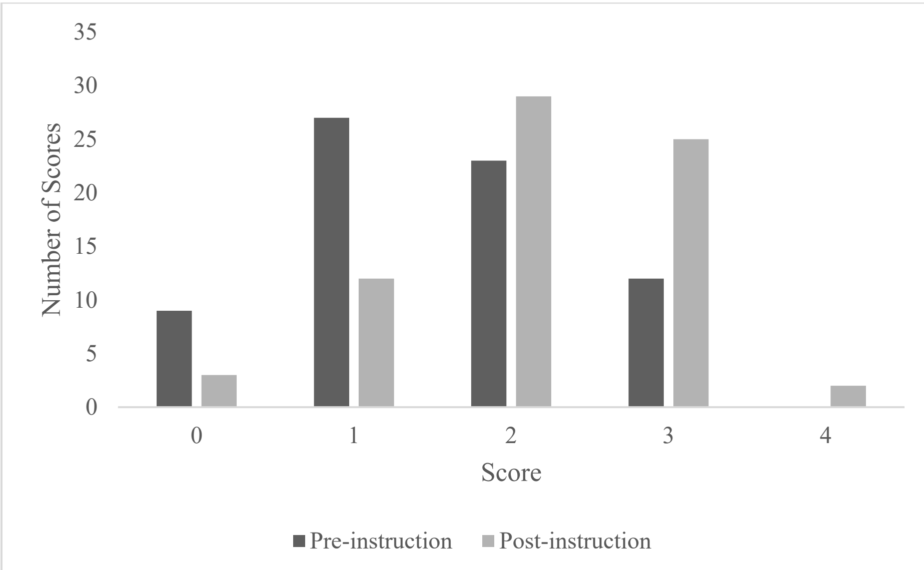


Table 3

Descriptive Statistics for Wilcoxon Signed-Rank Test for Statement of Purpose/Focus and Organization

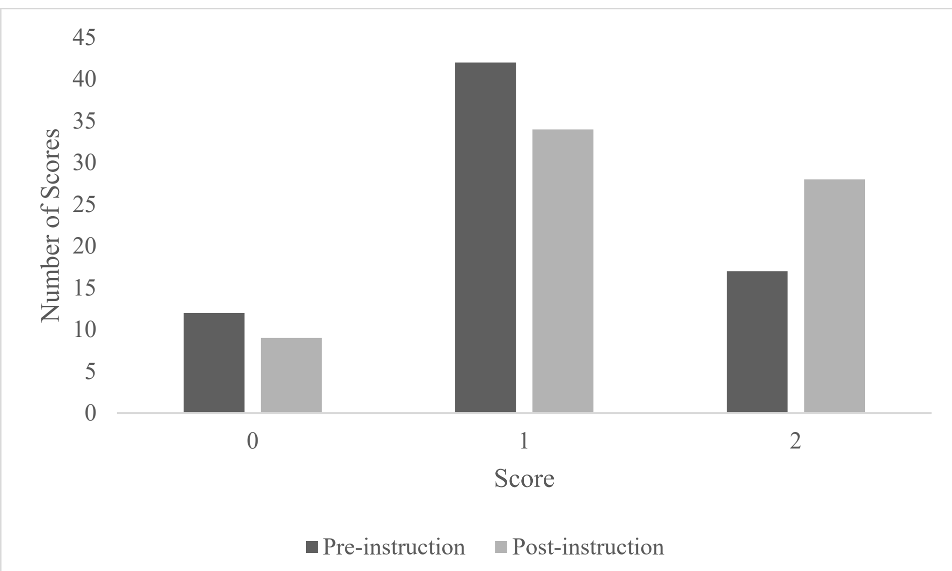
Sample				Percentiles		
	N	Minimum	Maximum	25th	50^{th} (Median)	75th
Pre-instruction	71	0	3	1.00	1.00	2.00
Post-instruction	71	0	4	2.00	2.00	3.00

Inferential Statistics. Next, the incorporation of statement of purpose/focus and organization in the pre-instruction and post-instruction writing samples was compared using a Wilcoxon signed-rank test. On average, students reported lower scores on the pre-instruction writing samples (*Mdn* = 1.00) than on the post-instruction writing samples (*Mdn* = 2.00). A Wilcoxon signed-rank test indicated that this difference was statistically significant, $z = -4.83$, $p < .001$. Therefore, the null hypothesis was rejected, suggesting that the instruction did result in an improvement in the statement of purpose/focus and organization portion of students' writing samples.

Conventions/Editing. The second element in the holistic rubric examined how well students employed conventions/editing in their writing. The assumptions for a Wilcoxon signed-rank test were checked first. The assumptions were that the data must be ordinal, the comparison must be between two related groups, and the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. The assumptions were all checked, and it was determined that these assumptions were met. A Wilcoxon signed-rank test was then performed. The frequency and the range of scores for the inclusion of the use of conventions/editing in writing for the pre- and post-instruction writing samples are shown in Figure 3.

Figure 3

Frequency Scores for Conventions/Editing



Descriptive Statistics. The range of scores was 0-2 with a possible range from 0-2 for both the pre-instruction writing samples and the post-instruction writing samples. The median scores and the percentile scores are listed in Table 4. Of the 71 participants in the study, 44 students demonstrated no improvement on conventions/editing on the post-instruction writing samples compared to the pre-instruction writing samples, whereas 21 participants demonstrated improvement and six participants reported lower scores from pre- to post-instruction.

Table 4

Descriptive Statistics for Wilcoxon Signed-Rank Test for Conventions/Editing

Sample				Percentiles		
	N	Minimum	Maximum	25th	50th (Median)	75th
Pre-Instruction	71	0	2	1.00	1.00	1.00
Post-instruction	71	0	2	1.00	1.00	2.00

Inferential Statistics. Next, the incorporation of writing conventions/editing in the pre-instruction and post-instruction writing samples were compared using a Wilcoxon signed-rank test. According to the median scores, students performed similarly on the pre-instruction writing samples (*Mdn* = 1.00) and on the post-instruction writing samples (*Mdn* = 1.00). A Wilcoxon signed-rank test, however, indicated that there *was* a small difference that was significant, $z = -.57$, $p = .011$. Therefore, the null hypothesis was rejected, suggesting a statistically significant difference pre- to post-instruction that indicated an improvement in the Conventions/Editing portion of students' writing samples.

Findings from the Total Holistic Rubric Scores

A paired-samples *t* test was used to analyze the total holistic rubric scores. The first step of this analysis was checking the assumptions. The first assumption was that data must be continuous, and the second was that the comparison must be between two related groups. These first two assumptions were met, because the total scores on a holistic rubric are considered continuous data, and the same group of students provided the pre-instruction and post-instruction writing samples. The next assumption was there could be no significant outliers, which was tested using a boxplot. This boxplot showed that there were no significant outliers. The final assumption was that there must be normality in the distribution of scores. A Normal Q-Q plot was used to test for normality, which did indicate normality in the distribution. Once it was determined that these assumptions were met, a paired-samples *t* test was then performed.

Descriptive Statistics. The descriptive statistics for the holistic rubric scores included the mean, standard deviation, variance, and the range, which are shown in Table 5. The boxplots are also shown in Figure 4. These descriptive statistics indicate that there were changes in student writing from the pre-instruction samples to the post-instruction samples. There were higher scores reported for the post-instruction writing samples (M = 3.42, SD = 1.411) as opposed to the pre-instruction writing samples (M = 2.61, SD = 1.378).

Table 5

Descriptive Statistics for Paired-Samples t Test of Total Holistic Scores

Sample	Mean	*N*	*SD*	Variance	Minimum	Maximum
Pre-instruction Total	2.61	71	1.378	1.91	0	5
Post-instruction Total	3.42	71	1.411	1.98	0	6

Inferential Statistics. A paired-samples *t* test was conducted to compare holistic rubric scores for the pre-instruction writing samples and the post-instruction writing samples. The resulting statistics are reported in Table 6. There was a significant difference ($t(70) = 5.92$, $p < .001$, two tailed) between the pre-instruction samples scores (M = 2.61, SD = 1.336) and the post-instruction samples scores (M = 3.44, SD = 1.422). Therefore, the null hypothesis was rejected, suggesting there was indeed a statistically significant difference between the pre- and post-instruction samples, indicating an overall improvement in the students' writing samples after the instruction. The effect size was also calculated using a Cohen's d test. The effect size was 0.695, which is a medium effect size according to Cohen (1988).

Figure 4

Boxplots of Total Holistic Rubric Scores

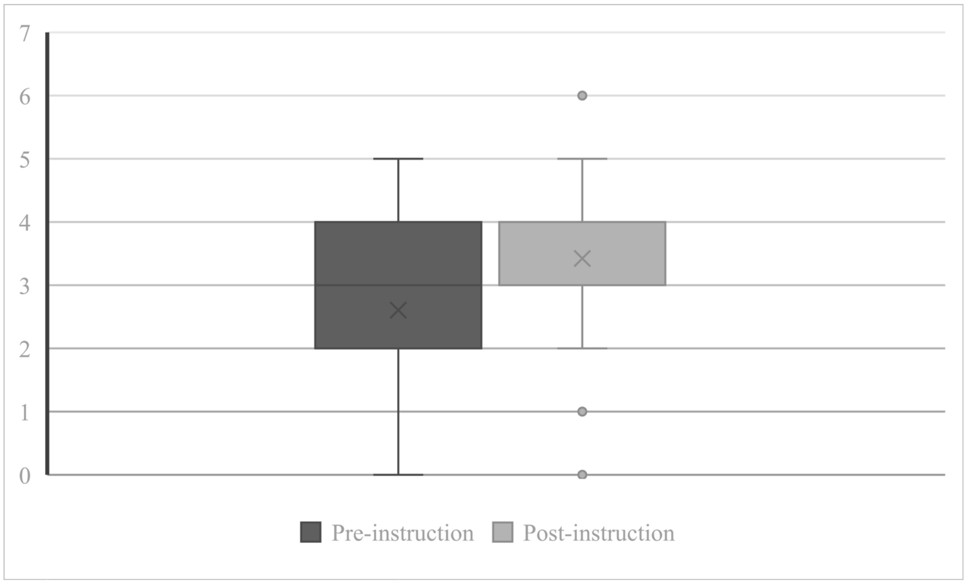


Table 6

Paired-Samples t Test for Total Holistic Rubric Scores

Pair	Paired differences							
				95% confidence interval of the difference				
	Mean	*SD*	Std. error mean	Lower	Upper	*t*	*df*	Sig. (two tailed)
Post-instruction – Pre-instruction	.817	1.163	.138	.542	1.092	5.920	70	.000

Inter-Rater Agreement on the Analytic Rubric

Because the analytic rubric was created specifically for this study, it was necessary to check inter-rater reliability before scores produced from the rubric could be analyzed. Cohen's Kappa was run to determine if there was agreement between 48 samples my chair and I each initially scored. According to the scale from Altman's (1999) guidelines, there was very good agreement between our scores on the analytic rubric, $\kappa = .836$, $p < .001$. Therefore, the rubric was considered reliable and was used to score the remaining writing samples.

Findings from the Individual Analytic Rubric Elements

In this section, the findings of the eight elements of the analytic rubric are presented. Using descriptive and inferential statistics, the frequency scores, ranks, median scores, *z* scores, and statistical significance from the Wilcoxon signed-rank test results for each element are shared.

Topic Introduction. The first element scored on the analytic rubric was the topic introduction. The assumptions for a Wilcoxon signed-rank test were checked first. The first assumption was that the data must be ordinal, and the second assumption was that the comparison must be between two related groups. These first two assumptions were met because the rubric scores were ordinal data, and the same group of participants provided the pre-instruction and post-instruction writing samples. The third assumption is that the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. A histogram was created to check this assumption, and the distribution was found to be roughly symmetrical. Once it was determined that these assumptions were met, a Wilcoxon signed-rank test was then performed. The frequency and the range of scores for the inclusion of a topic introduction in writing for the pre- and post-instruction writing samples are shown in Figure 5.

Descriptive Statistics. The range in scores for the topic introduction on both the pre-instruction writing samples and the post-instruction writing samples was 0-4 with a possible range of 0-4. The median scores and the percentile scores are listed in Table 7. Of the 71 participants in the study, 30 participants demonstrated no improvement on the topic introduction rubric element in the post-instruction writing samples compared to the pre-instruction writing samples, while 22 participants demonstrated improvement and 19 participants reported lower scores from pre-to post-instruction.

Figure 5

Frequency Scores for Topic Introduction

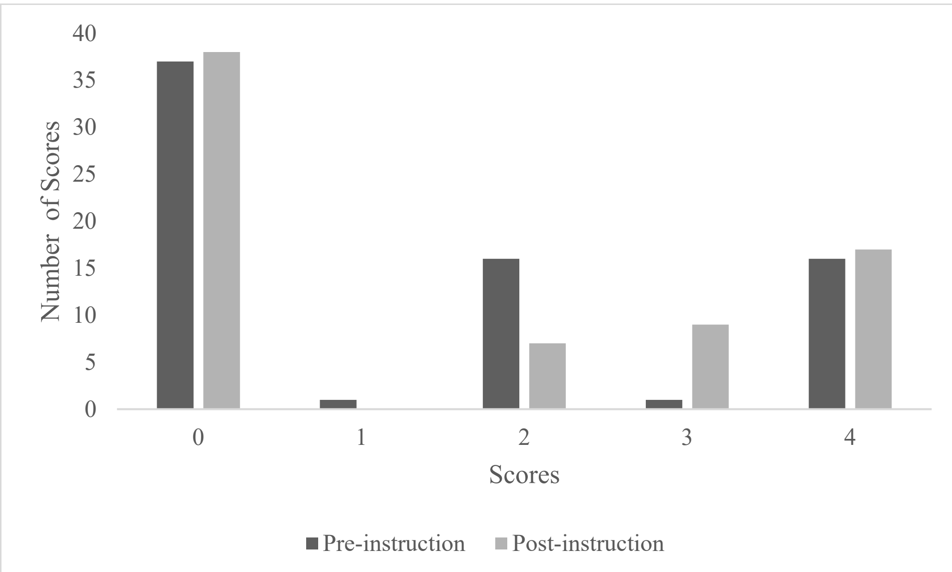


Table 7

Descriptive Statistics for Wilcoxon Singed-Rank Test for Topic Introduction

Sample				Percentiles		
	N	Minimum	Maximum	25th	50^{th} (Median)	75th
Pre-instruction	71	0	4	0.00	0.00	2.00
Post-instruction	71	0	4	0.00	0.00	3.00

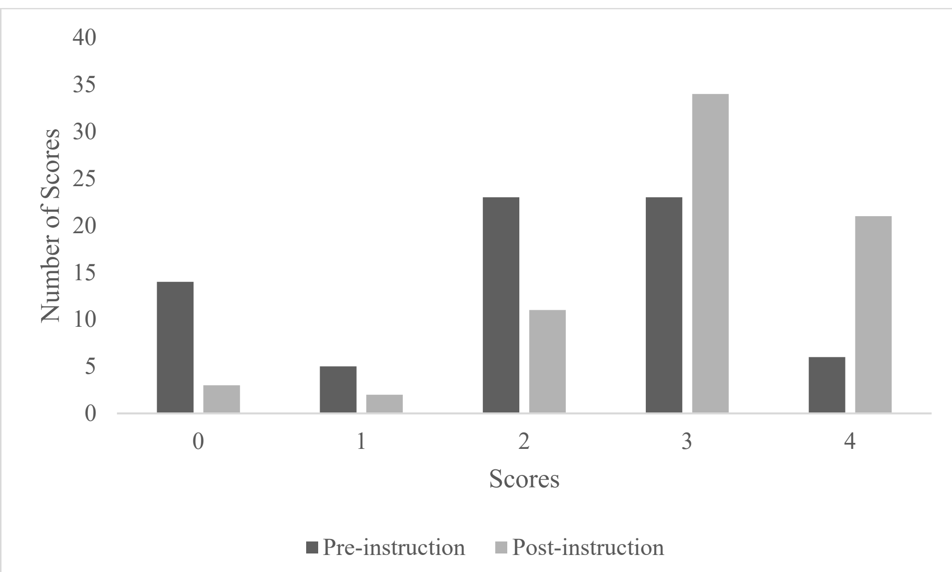
Inferential Statistics. Next, the incorporation of a topic introduction in the pre-instruction and post-instruction writing samples were compared using a Wilcoxon signed-rank test. On average, students performed similarly on the introduction portion of the pre-instruction writing samples (*Mdn* = 0.00) as on post-instruction writing samples (*Mdn* = 0.00). A Wilcoxon signed-rank test indicated that any difference was not statistically significant, $z = -0.43$, $p = .664$.

Therefore, the null hypothesis was not rejected, suggesting the instruction did not result in a statistically significant difference in the topic introduction portion of the students' writing samples.

Steps of the Plant Life Cycle. The second element scored on the analytic rubric is the steps of the plant life cycle. The assumptions for a Wilcoxon signed-rank test were checked first. These assumptions were that the data must be ordinal, that the comparison must be between two related groups, and that the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. Once it was determined that these assumptions were met, a Wilcoxon signed-rank test was then performed. The frequency and the range of scores for the steps of the plant life cycle for the pre- and post-instruction writing samples are shown in Figure 6.

Figure 6

Frequency Scores for Steps of the Plant Life Cycle



Descriptive Statistics. The range in scores for the steps of the plant life cycle for both the pre-instruction and post-instruction writing samples was 0-4 with a possible range of 0-4. The median scores and the percentile scores are listed in Table 8. Of the 71 participants in the study, 42 demonstrated improvement on the steps of the plant life cycle rubric element in the post-instruction writing samples compared to the pre-instruction writing samples, whereas 22 participants made no improvement and seven participants reported lower scores from pre- to post-instruction.

Table 8

Descriptive Statistics for Wilcoxon Singed-Rank Test for Steps of the Plant Life Cycle

Sample				Percentiles		
	N	Minimum	Maximum	25th	50th (Median)	75th
Pre-instruction	71	0	4	1.00	2.00	3.00
Post-instruction	71	0	4	3.00	3.00	4.00

Inferential Statistics. Next, the incorporation of steps of the plant life cycle in the pre-instruction and post-instruction writing samples were compared using a Wilcoxon signed-rank test. On average, students reported lower scores on the steps of the plant life cycle rubric element on the pre-instruction writing samples (*Mdn* = 2.00) than on post-instruction writing samples (*Mdn* = 3.00). A Wilcoxon signed-rank test indicated that this difference was statistically significant, $z = -5.04$, $p < .001$. Therefore, the null hypothesis (that there is no statistically significant difference between the two groups) was rejected, suggesting that the instruction did result in an improvement in the steps of the plant life cycle portion of students' writing samples.

Concluding Statement. The third rubric element scored on the analytic rubric was the concluding statement. The assumptions for a Wilcoxon signed-rank test were checked first. These assumptions were that the data must be ordinal, that the comparison must be between two related groups, and that the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. Once it was determined that these assumptions were met, a Wilcoxon signed-rank test was then performed. The frequency and the range of scores for the inclusion of a concluding statement in writing for the pre- and post-instruction writing samples are shown in Figure 7.

Descriptive Statistics. The range in scores for the concluding statement on the pre-instruction and post-instruction writing samples was 0-4 with a possible range of 0-4. The median scores and the percentile scores are listed in Table 9. Of the 71 participants in the study, 11 students demonstrated improvement on the concluding statement rubric element in the post-instruction writing samples compared to the pre-instruction writing samples, whereas 50 participants saw no improvement and 10 participants reported lower scores from pre- to post-instruction.

Figure 7

Frequency Scores for Concluding Statement

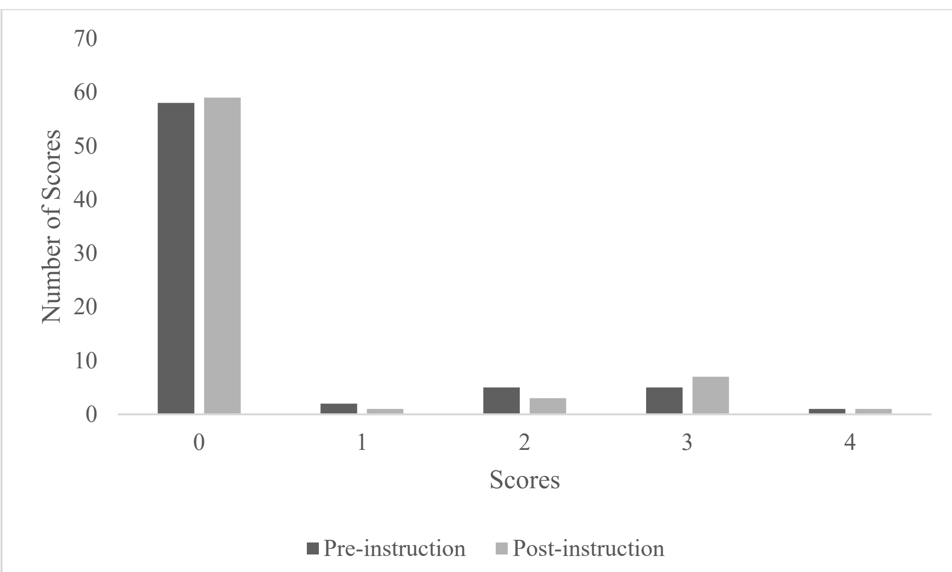


Table 9

Descriptive Statistics for Wilcoxon Signed-Rank test for Concluding Statement

Sample				Percentiles		
	N	Minimum	Maximum	25th	50^{th} (Median)	75th
Pre-instruction	71	0	4	0.00	0.00	0.00
Post-instruction	71	0	4	0.00	0.00	0.00

Inferential Statistics. Next, the incorporation of a concluding statement in the pre-instruction and post-instruction writing samples were compared using a Wilcoxon signed-rank test. On average, students performed similarly on the concluding statement portion of the pre-instruction writing samples (Mdn = 0.00) and on post-instruction writing samples (Mdn = 0.00). A Wilcoxon signed-rank test indicated that any difference was not statistically significant, z = -0.11, p = .916. Therefore, the null hypothesis was not rejected, suggesting the instruction did not result in a change in the concluding statement portion of students' writing samples.

Signal Words. The next rubric element scored on the analytic rubric was signal words. The assumptions for a Wilcoxon signed-rank test were checked first. These assumptions were that the data must be ordinal, that the comparison must be between two related groups, and that the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. Once it was determined that these assumptions were met, a Wilcoxon signed-rank test was then performed. The frequency and the range of scores for the inclusion of signal words in writing for the pre- and post-instruction writing samples are shown in Figure 8.

Descriptive Statistics. The range in scores for signal words on both the pre-instruction writing samples and post-instruction writing samples was 0-4, with a possible range of 0-4. The median scores and the percentile scores are listed in Table 10. Of the 71 participants in the study, 46 demonstrated improvement on signal words on the post-instruction writing samples compared to the pre-instruction writing samples, whereas 19 participants saw no improvement and six participants reported lower scores from pre- to post-instruction.

Figure 8

Frequency Scores for Signal Words

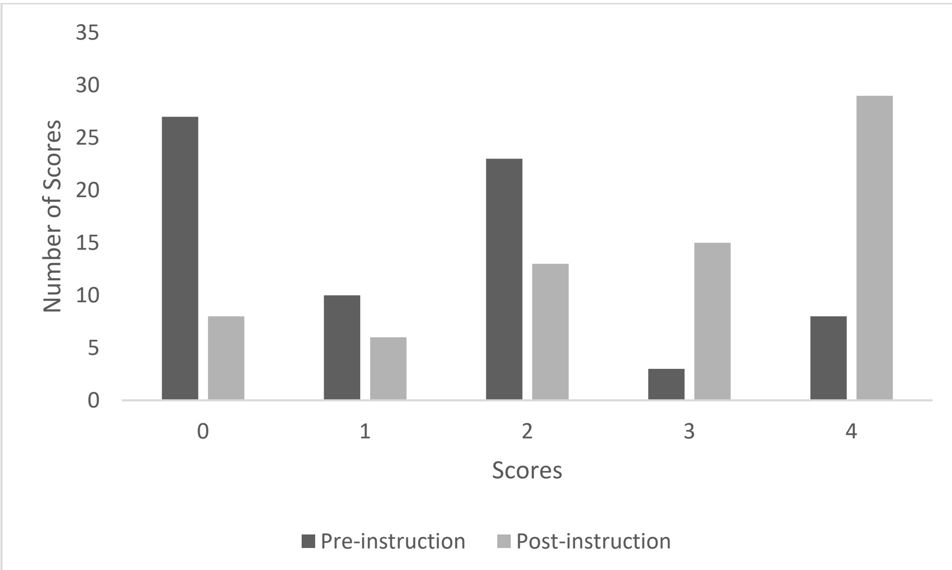


Table 10

Descriptive Statistics for Wilcoxon Signed-Rank Test for Signal Words

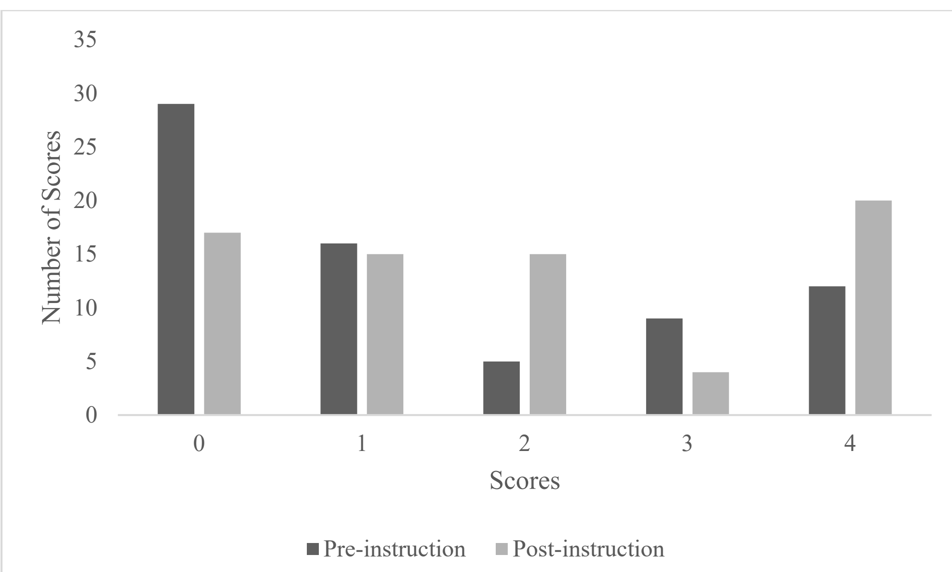
Sample				Percentiles		
	N	Minimum	Maximum	25th	50th (Median)	75th
Pre-instruction	71	0	4	0.00	1.00	2.00
Post-instruction	71	0	4	2.00	3.00	4.00

Inferential Statistics. Next, incorporation of signal words in the pre-instruction and post-instruction writing samples were compared using a Wilcoxon signed-rank test. On average, students reported lower scores for signal words on the pre-instruction writing samples (*Mdn* = 1.00) than on the post-instruction writing samples (*Mdn* = 3.00). A Wilcoxon signed-rank test indicated that this difference was statistically significant, $z = -5.82$, $p < .001$. Therefore, the null hypothesis was rejected, suggesting there was a statistically significant difference from pre-to post-instruction, indicating that the instruction did result in an improvement in the use of signal words in students' writing samples.

Capitalization at the Beginning of Sentences. The next rubric element scored on the analytic rubric was capitalization at the beginning of sentences. The assumptions for a Wilcoxon signed-rank test were checked first. These assumptions were that the data must be ordinal, that the comparison must be between two related groups, and that the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. Once it was determined that these assumptions were met, a Wilcoxon signed-rank test was then performed. The frequency and the range of scores for the inclusion of capitalization at the beginning of sentences in writing for the pre- and post-instruction writing samples are shown in Figure 9.

Figure 9

Frequency Scores for Capitalization at the Beginning of Sentences



Descriptive Statistics. The range in scores for capitalization at the beginning of sentences on both the pre-instruction writing samples and the post-instruction writing samples was 0-4 with a possible range of 0-4. The median scores and the percentile scores are listed in Table 11. Of the 71 participants in the study, 31 reported improvement on capitalization at the beginning of sentences on the post-instruction writing samples compared to the pre-instruction writing samples, whereas 31 participants saw no improvement and 9 participants reported lower scores for capitalization at the beginning of sentences from pre- to post-instruction.

Table 11

Descriptive Statistics for Wilcoxon Singed-Rank Test for Capitalization at the Beginning of Sentences

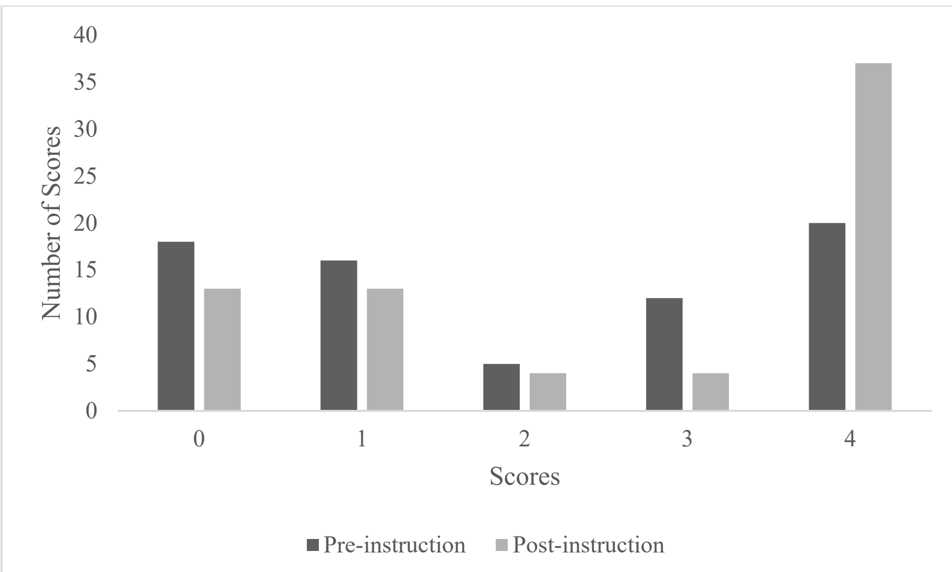
Sample				Percentiles		
	N	Minimum	Maximum	25th	50^{th} (Median)	75th
Pre-instruction	71	0	4	.00	1.00	3.00
Post-Instruction	71	0	4	1.00	2.00	4.00

Inferential Statistics. Next, the incorporation of capitalization at the beginning of sentences in the pre-instruction and post-instruction writing samples were compared using a Wilcoxon signed-rank test. On average, students reported lower scores on the pre-instruction writing samples (*Mdn* = 1.00) than on the post-instruction writing samples (*Mdn* = 2.00). A Wilcoxon signed-rank test indicated that this difference was statistically significant, $z = -3.09$, $p = .002$. Therefore, the null hypothesis was rejected, suggesting there was a statistically significant difference between pre- and post-instruction, indicating the instruction did result in improvement in the capitalization at the beginning of sentences portion of students' writing samples.

Ending Punctuation. The next rubric element scored on the analytic rubric was ending punctuation. The assumptions for a Wilcoxon signed-rank test were checked first. These assumptions were that the data must be ordinal, that the comparison must be between two related groups, and that the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. Once it was determined that these assumptions were met, a Wilcoxon signed-rank test was then performed. The frequency and the range of scores for the inclusion of ending punctuation in writing for the pre- and post-instruction writing samples are shown in Figure 10.

Figure 10

Frequency Scores for Ending Punctuation



Descriptive Statistics. The range in scores for ending punctuation on both the pre-instruction writing samples and the post-instruction writing samples was 0-4 with a possible range of 0-4. The median scores and the percentile scores are listed in Table 12. Of the 71 participants in the study, 29 demonstrated improvement on ending punctuation in the post-instruction writing samples compared to the pre-instruction writing samples, whereas 30 participants saw no improvement and 12 reported lower scores from pre- to post-instruction.

Table 12

Descriptive Statistics for Wilcoxon Signed-Rank Test for Ending Punctuation

Sample				Percentiles		
	N	Minimum	Maximum	25th	50th (Median)	75th
Pre-instruction	71	0	4	.00	2.00	4.00
Post-instruction	71	0	4	1.00	4.00	4.00

Inferential Statistics. Next, the incorporation of ending punctuation in the pre-instruction writing samples and post-instruction writing samples were compared using a Wilcoxon signed-rank test. On average, students reported similar or lower scores on the ending punctuation portion of the pre-instruction writing samples (*Mdn* = 2.00) than on post-instruction writing samples (*Mdn* = 4.00). A Wilcoxon signed-rank test indicated that this difference was statistically significant, $z = -2.44$, $p = .015$. Therefore, the null hypothesis was rejected, suggesting a statistically significant difference between pre- and post-instruction samples, indicating that the instruction did result in an improvement in the ending punctuation portion of students' writing samples.

Spelling. The next element scored on the analytic rubric was spelling. The assumptions for a Wilcoxon signed-rank test were checked first. These assumptions were that the data must be ordinal, that the comparison must be between two related groups, and that the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. Once it was determined that these assumptions were met, a Wilcoxon signed-rank test was then performed. The frequency and the range of scores for the inclusion of spelling in writing for the pre- and post-instruction writing samples are shown in Figure 11.

Descriptive Statistics. The range in scores for spelling on both the pre-instruction writing samples and the post-instruction writing samples was 0-4 with a possible range of 0-4. The median scores and the percentile scores are listed in Table 13. Of the 71 participants in the study, 17 demonstrated improvement in spelling on the post-instruction writing samples compared to the pre-instruction writing samples, whereas 43 participants saw no improvement and 11 reported lower scores from pre- to post-instruction.

Figure 11

Frequency Scores for Spelling

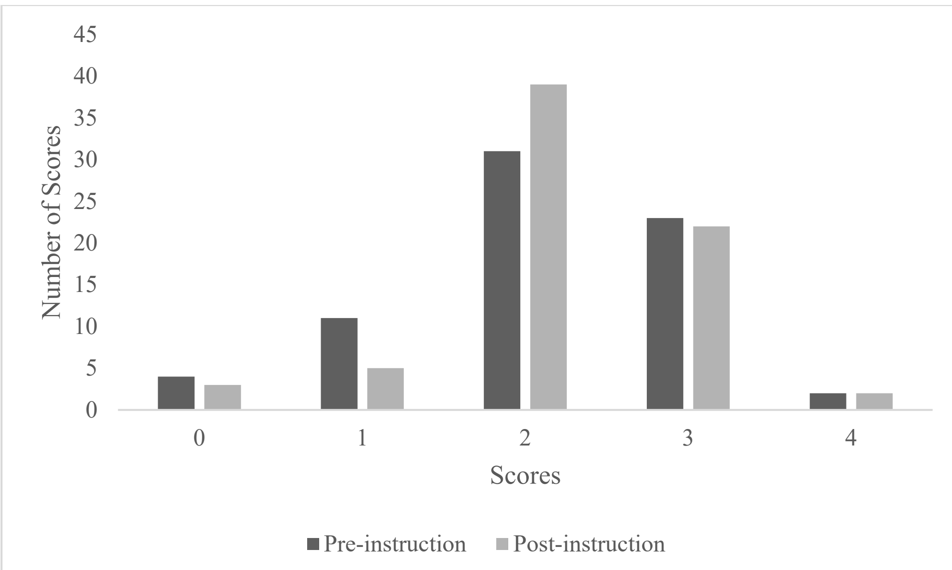


Table 13

Descriptive Statistics for Wilcoxon Signed-Rank Test for Spelling

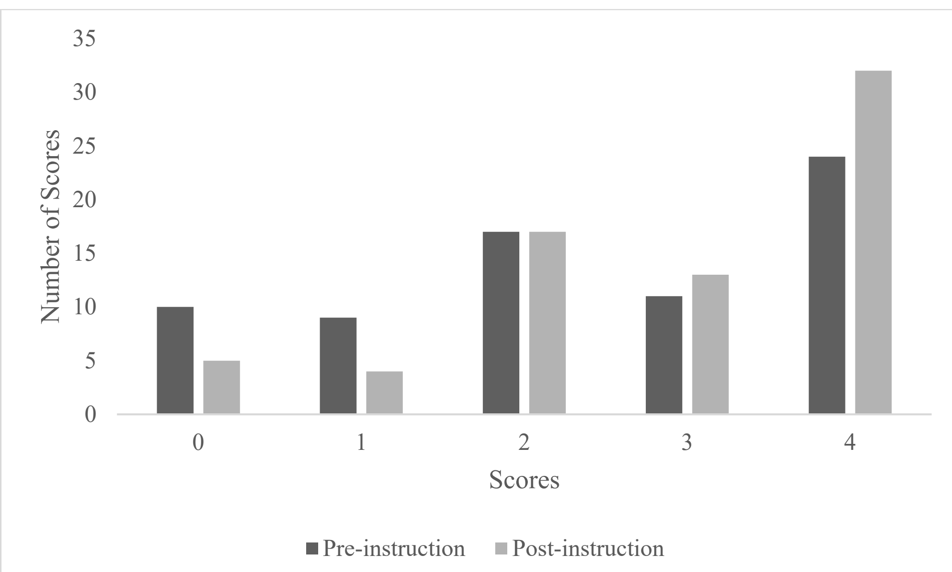
Sample				Percentiles		
	N	Minimum	Maximum	25th	50th (Median)	75th
Pre-instruction	71	0	4	2.00	2.00	3.00
Post-instruction	71	0	4	2.00	2.00	3.00

Inferential Statistics. Next, the spelling scores for pre-instruction and post-instruction writing samples were compared using a Wilcoxon signed-rank test. On average, students reported similar spelling performance on the pre-instruction writing samples (*Mdn* = 2.00) as on the post-instruction writing samples (*Mdn* = 2.00). A Wilcoxon signed-rank test indicated that any differences were not statistically significant, $z = -1.04$, $p = .299$. Therefore, the null hypothesis was not rejected, suggesting the instruction did not result in changes in spelling performance on students' writing samples.

Word Count. The next rubric element scored on the analytic rubric was word count. assumptions for a Wilcoxon signed-rank test were checked first. These assumptions were that the data must be ordinal, that the comparison must be between two related groups, and that the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. Once it was determined that these assumptions were met, a Wilcoxon signed-rank test was then performed. The frequency and the range of scores for word count in writing for the pre- and post-instruction writing samples are shown in Figure 12.

Figure 12

Frequency Scores for Word Count



Descriptive Statistics. The range in scores for word count on both the pre-instruction writing samples and the post-instruction writing samples was 0-4 with a possible range of 0-4. The median scores and the percentile scores are listed in Table 14. Of the 71 participants in the study, 30 demonstrated improvement on the word count rubric element in the post-instruction writing samples compared to the pre-instruction writing samples, whereas 27 participants saw no improvement and 14 reported lower scores from pre- to post-instruction.

Table 14

Descriptive Statistics for Wilcoxon Singed-Rank Test for Word Count

Sample				Percentiles		
	N	Minimum	Maximum	25th	50th (Median)	75th
Pre-instruction	71	0	4	1.00	2.00	4.00
Post-instruction	71	0	4	2.00	3.00	4.00

Inferential Statistics. Next, word count scores in the pre-instruction and post-instruction writing samples were compared using a Wilcoxon signed-rank test. On average, students reported similar or lower word count scores on the pre-instruction writing samples (*Mdn* = 2.00) than on post-instruction writing samples (*Mdn* = 3.00). A Wilcoxon signed-rank test indicated that the difference was statistically significant, $z = -2.72$, $p = .007$. Therefore, the null hypothesis was rejected, suggesting there was a statistically significant difference between pre- and post-instruction samples, indicating that the instruction did result in an improvement on the word count portion of students' writing samples.

Findings from the Total Weighted Analytic Rubric Scores

Analysis began with checking the assumptions for a paired-samples *t* test. The assumptions were that data must be continuous, that the comparison must be between two related groups, that there could be no significant outliers, and that there must be normality in the distribution of scores. The assumptions were met, with the exception of the no significant outliers assumption. A boxplot showed that there was one outlier detected that was more than 1.5 box-lengths from the edge in a boxplot. Inspection of its value did not reveal it to be extreme, thus it was retained in the analysis. Once it was determined that these assumptions were met, a paired-samples *t* test was then performed.

Descriptive Statistics. The descriptive statistics for the total weighted analytic rubric scores included the mean, standard deviation, variance, and the range, which are shown in Table 15. Boxplots are also shown in Figure 13. These descriptive statistics indicate that there were improvements in student writing from the pre-instruction samples to the post-instruction samples. Participants performed better on the post-instruction writing samples ($M = 2.21$, $SD = 0.806$) as opposed to the pre-instruction writing samples ($M = 1.56$, $SD = 0.861$).

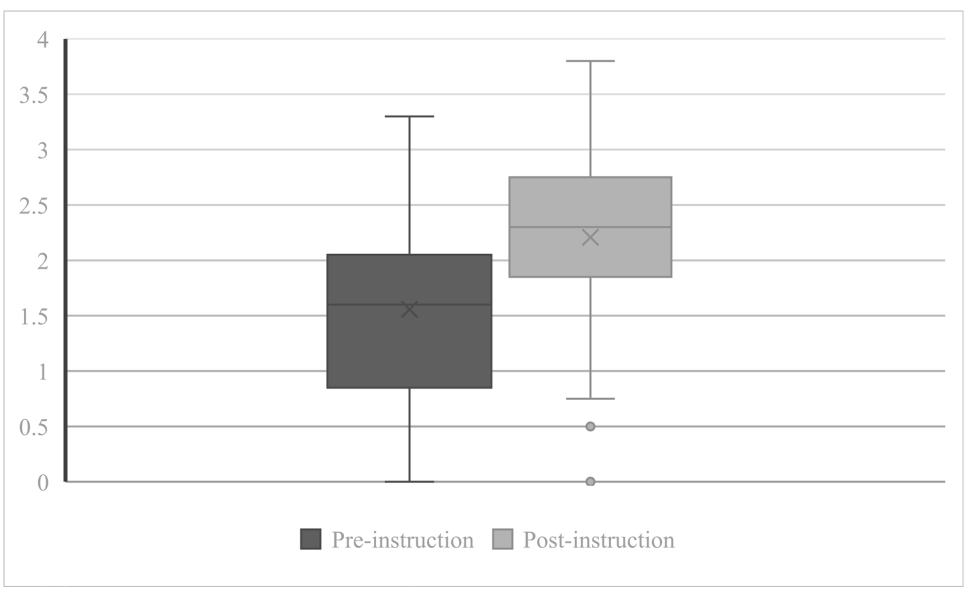
Table 15

Descriptive Statistics for Paired-Samples t Test for Total Weighted Analytic Rubric Scores

Sample	Mean	*N*	*SD*	Variance	Minimum	Maximum
Pre-instruction Total	1.56	71	.861	.74	0.00	3.30
Post-instruction Total	2.21	71	.806	.65	0.00	3.80

Figure 13

Boxplots of Total Weighted Analytic Rubric Scores



Inferential Statistics. A paired-samples *t* test was conducted to compare total weighted analytic rubric scores for the pre-instruction writing samples to the total weighted analytic rubric scores for the post-instruction writing samples. The resulting statistics are reported in Table 16. There was a significant difference [$t(70) = 6.613$, $p < .001$, two tailed] between the pre-instruction samples scores ($M = 1.56$, $SD = 0.861$) and the post-instruction sample scores ($M = 2.21$, $SD = 0.806$). Therefore, the null hypothesis (that there was no difference between pre- and post-instruction samples) was rejected, indicating a statistically significant difference between pre- and post-instruction samples, revealing an overall improvement in the students' writing samples after instruction, using a combination of integrated science and literacy instruction with specific writing instruction in expository text. The effect size was also calculated using a Cohen's d test. The effect size was 0.784, which is a medium effect size according to Cohen (1988).

Table 16

Paired-Samples t Test for Total Weighted Analytic Rubric Scores

Pair	Paired differences							
				95% confidence interval of the difference				
	Mean	*SD*	Std. error mean	Lower	Upper	*t*	*df*	Sig. (two tailed)
Post-instruction – Pre-instruction	.651	.830	.099	.455	.848	6.613	70	.000

Research Question Two

The second research question was, "Do student rubric scores on the writing samples vary based on whether writing samples are scored using a holistic or analytic rubric?" To answer this question, a Wilcoxon signed-rank test was conducted using the total scores garnered from using each rubric. The ranks produced were then examined to see how the scores varied.

The assumptions for a Wilcoxon signed-rank test were checked first. The first assumption was that the data must be ordinal, and the second assumption was that the comparison must be between two related groups. These first two assumptions were met because the rubric scores were ordinal data, and the same group of participants provided the pre-instruction and post-instruction writing samples. The third assumption is that the distribution of the differences between the pre-instruction and post-instruction scores must be symmetrical. A histogram was created to check this assumption, and the distribution was found to be roughly symmetrical. Once it was determined that these assumptions were met, a Wilcoxon signed-rank test was then performed on each rubric's total scores. The descriptive statistics are listed in Table 17. Both rubrics show an improvement in the median score. The ranks for each test are shown in Table 18. The ranks for the two rubrics are not similar except that both rubrics show a majority of the students had positive ranks, indicating that scores vary when samples are scored by the two different types of rubrics.

Table 17

Descriptive Statistics for Wilcoxon Singed-Rank Test for Both Rubrics

Data Set				Percentiles		
	N	Minimum	Maximum	25th	50^{th} (Median)	75th
Holistic Pre-instruction	71	0	5	2.00	3.00	4.00
Holistic Post-instruction	71	0	6	3.00	4.00	5.00
Analytic Pre-instruction	71	0	3.30	.85	1.60	2.05
Analytic Post-instruction	71	0	3.80	1.85	2.30	2.75

Table 18

Positive, Negative, and Tied Scores Produced Using a Wilcoxon Signed-Rank Test

Data Set	Negative Ranks	Positive Ranks	Ties
Total Holistic Score Differences	9	45	17
Total Weighted Analytic Score Differences	13	56	2

CHAPTER 5

Discussion

Many students reach adulthood without the necessary writing skills to perform well in higher education or employment (Cutler & Graham, 2008). The problem may be that learning to write is difficult (Graham, Berninger, & Abbott, 2012; Graham, Bolinger, et al., 2012; Harris et al., 2006), and there may be concerns about the way writing has been traditionally taught in elementary schools (Pearson et al., 2010). An important aim of the ELA-CCSS was to help students learn to write in a variety of ways and at younger ages in order to help them write for various purposes and be ready for college and employment (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). These standards require that even young children learn to write narrative, argumentative, and expository text (Richards et al., 2012; T. Shanahan, 2015a). Furthermore, these standards communicated new writing goals but provided little information on how teachers are to meet these instructional goals (Graham et al., 2015; T. Shanahan, 2015a). Previously, expository writing had not been taught until children reach the upper elementary grades (Chall & Jacobs, 2003; Duke, 2000; Maloch & Bomer, 2013; Yopp & Yopp, 2012). Given the need young children have for support in the early stages of their writing, it is imperative that schools and educators are provided with evidence-based recommendations for writing instruction designed to teach young children to write expository text and recommendations for how to evaluate the writing young children produce.

Previous research investigated various methods for teaching writing, and traditional and integrated instructional methods have had varying levels of success. However, instructional methods such as Writer's Workshop (see Atwell, 1987; Calkins, 1986; Graves, 1983) and Shared Writing and Interactive Writing (see Hammerberg, 2001) are limited by not allowing students the chance to develop the content knowledge necessary for writing expository text. Integrated instruction such as Concept-Oriented Reading Instruction (Guthrie et al., 1994), Guided Inquiry Supporting Multiple Literacies (Magnusson & Palincsar, 1995), and In-Depth Expanded Application of Science (Romance & Vitale, 2001) is limited by a primary focus on reading and by a lack of specific writing instruction. A possible solution is to combine integrated science and literacy instruction with intentional and specific writing instruction.

This study had two important objectives. The first was to determine how the science expository text writing of second-grade students was affected by an instructional method that combined an integrated science and literacy curriculum with writing instruction to teach students to write expository text. The second objective was to determine how student scores varied based on whether the holistic or analytic rubric was used to score student writing.

In the first section of this chapter, a discussion of the results stemming from this research is presented. In the next section, I highlight the strengths and limitations of the study. This is followed by recommendations for future research, a discussion of the implications of this research, and a concluding section.

Research Question One

The first research question was, "How does an integrated science and literacy instructional approach combined with a writing instructional strategy designed specifically for teaching expository text influence the science expository text written by second-grade students?" To answer this question, both a holistic and a weighted analytic rubric were used to score student writing samples before and after the instruction. A paired-samples *t* test was used to compare the total weighted scores gathered using the holistic rubric and the results indicated improvement in second-grade students' science expository text writing. A paired-samples *t* test used to compare the total weighted scores from the analytic rubric also indicated improvement in second-grade student's science expository text writing. A Cohen's *d* effect size measure indicated a medium effect size on scores from both rubrics. This result was not surprising, as a general improvement would be expected given the positive effect of previous integrated science and literacy instruction on supporting children as they learn content knowledge (see Guthrie et al., 1996; Guthrie & Alao, 1997; Guthrie et al., 1998; Palincsar et al., 2001; Romance & Vitale, 2001) and positive results of instruction that teaches students to write expository text (see Clark et al., 2013; Clark & Neal, 2018).

These results, however, do not answer the question of *how* the instruction affected student writing. The paired-samples *t* tests demonstrated that the instruction had a statistically significant effect. In order to determine the specific ways student writing changed, the results of a Wilcoxon signed-rank test for each element of each rubric must be examined.

The first element of the holistic rubric was Statement of Purpose/Focus and Organization, which included the topic introduction, facts presented, and the conclusion. On this element, most students either improved or maintained their score from pre-instruction to post-instruction and the median score increased. However, because this over-arching element covered multiple factors, it is still somewhat difficult to determine the specific ways student writing improved over time.

The second element of the holistic rubric was Conventions/Editing. These scores also indicated a statistically significant change from pre- to post-instruction, although the median score remained the same. This lack of a change in median score was likely caused by the smaller range of possible scores (zero to two) at the post-instruction stage compared to the pre-instruction stage. The improvement in Conventions/Editing can be attributed to the examples of good sentence structure, capitalization, punctuation, and spelling in the mentor texts and to teacher modeling of good writing conventions. This finding also supports research that similarly found improvement in writing conventions after expository writing instruction (see Clark & Neal, 2018) and supports the assertion that writing conventions are an important part of writing for second-grade students (Graham et al., 2003).

Of the eight elements included in the analytic rubric, three of them indicated that the effect of the instruction had no statistical significance. These included the topic introduction, concluding statement, and spelling. The results that indicated that the students' spelling did not improve after the instruction was not surprising because spelling was not emphasized or included in any part of the instruction other than the modeling provided by teachers and the examples of appropriate spelling used in the mentor texts. On the other hand, students were taught how to incorporate an introduction and a conclusion during the instruction, thus it was somewhat surprising that there was no statistically significant difference in the writing samples for this rubric element from pre- to post-instruction. However, there are a couple possible reasons for this. First, only one day of the instruction was dedicated to teaching students how to incorporate introductions and conclusions in their writing. Learning to write introductions and conclusions are difficult tasks for second-grade students to master, thus one session may not have been enough time to influence student writing in this area. Second, the authors who wrote the mentor texts used throughout the instruction did not necessarily employ introductions and/or conclusions in their writing either, and therefore these mentor texts were not necessarily good examples of introductions and/or conclusions.

The findings related to the remaining elements of the analytic rubric all reported a statistically significant effect when comparing pre- and post-instruction writing samples. These rubric elements included steps of the plant life cycle, signal words, capitalization at the beginning of sentences, ending punctuation, and word count. The rubric scores for the steps of the plant life cycle showed that a majority of students improved their score in this area of their writing, and the median score also improved. This was expected due to the amount of hands-on activities and mentor texts used in the integrated instruction over the course of seven class sessions (see Appendix F), which allowed time for the students to develop their content knowledge on the life cycle of plants. This finding is consistent with Bollinger and Smith's (2001) claim that knowledge is understanding gained through experience, study, investigation, or observation. It is also consistent with research indicating that when science and literacy are integrated during instruction, it leads to an increase in content knowledge (see Guthrie et al., 1996; Guthrie & Alao, 1997; Guthrie et al., 1998; Palincsar et al., 2001; Romance & Vitale, 2001) and that science understanding and writing performance are positively correlated (Cervetti et al., 2012).

The scores reporting how well students included signal words in their sequential expository text demonstrated that students improved from pre- to post-instruction, and the median score for signal words also increased. One explanation for this is that signal words were heavily emphasized as part of the instruction. Additionally, many of the mentor texts used throughout the instruction included signal words being used to demonstrate a sequence (see Aloian, 2012b; Gibbons, 1991; Goodman, 2009; Hansen, 2016c; Owings, 2017a, 2017b; Schuh, 2017a, 2017b). Furthermore, the plant life cycle itself is a sequence and therefore naturally lends itself to the sequential expository structure. This natural tendency may also explain why so many students (19) had no improvement in score. A majority of these students scored a four on the pre-instruction writing sample, giving themselves no room for improvement.

Scores for capitalization at the beginning of sentences also showed improvement pre-instruction to post-instruction, and the median score also improved. This was unexpected, as capitalization was not specifically part of the instruction other than teacher modeling and examples in mentor texts. Additionally, an equal number of students improved and tied their scores pre- to post-instruction. An investigation of the data showed that a majority of these students made no improvement with a score of zero or one, but because the median improved, the remaining students who made no improvement had higher scores, and 15 of those who improved increased by two or more points.

The scores for the next element, ending punctuation, similarly showed improvement. The median score also improved. Like capitalization at the beginning of sentences, this was not part of the instruction and can only be attributed to teacher modeling and examples in the mentor texts. It is also noteworthy that for this element, the ranked scores showed more ties than positive ranks, meaning that there were more students who made no improvement than students who made improvement. However, of those who tied, a majority of them earned a four on both the pre-instruction and post-instruction writing samples, so no improvement was possible. This finding suggests that there may be a ceiling effect with this rubric element.

Word count scores also showed statistically significant improvement, and the median score improved. Of the 30 students who improved their word count score, it should be noted that 21 of them also improved their scores on steps of the plant life cycle. This increase indicated the development of content knowledge, likely giving the students more to write about and increasing their word count. Similarly, all but one of the students who improved their word count score also improved their total scores. This is consistent with researchers who determined that the length of student writing (as measured by word count) can indicate writing quality (Clark & Neal, 2018;

Lienemann et al., 2006; Morphy & Graham, 2012; Purcell-Gates et al., 2007). Furthermore, of the 27 students who maintained their word count score, 26 either improved (16) or maintained (10) their score on steps of the plant life cycle. Interestingly, of the 14 students whose scores declined in word count, their scores also generally improved (four) or were maintained (six) in the area of steps of the plant life cycle, possibly indicating that their development of content knowledge may have helped them write more succinctly. However, of these same students whose word count scores declined, just over half (eight) also saw their total scores (which indicates overall quality) decline. This finding contradicts the assertion of Festas et al. (2015) that as students gain writing experience, their writing is more succinct and of higher quality.

Research Question Two

The second research question was, “Do student rubric scores on the writing samples vary based on whether writing samples are scored using a holistic or analytic rubric?” This question was answered by examining the ranks produced through Wilcoxon signed-rank tests of the total scores from each rubric to see how similarly the rubrics scored. An examination of these ranks indicated that scores do vary based on the rubric that is used.

When looking at the positive ranks (students that did better on the post-instruction writing sample than the pre-instruction writing sample), the holistic rubric showed that 45 students made improvement, while the analytic rubric showed that 56 students made improvement. It was expected that both rubrics would show many students improving between pre-instruction and post-instruction, but the disparity in the number of students improving between the rubrics was unanticipated. This disparity could be due to the way the analytic rubric was weighted, giving heaviest emphasis to the element of steps of the plant life cycle and considering it separately from all other elements. The vast majority of students improved their score in this area, which could have inflated improvement in the analytic rubric over the holistic rubric. Furthermore, the scores for the holistic rubric were less specific, because the points made were considered in conjunction with introductions and conclusions, for which the analytic rubric showed no improvement.

The tied ranks (students whose scores were the same on both writing samples) showed that 17 students tied on the holistic rubric, while only two tied on the analytic rubric. This result was not surprising. Due to the way the elements on the analytic rubric were individually scored and then weighted and combined, it would be extremely unlikely for a student to achieve the exact same score on the pre-instruction sample and the post-instruction sample. In fact, the only two scores that were tied were two students who wrote very little and earned a zero for the total scores each time. Conversely, because the holistic rubric was more general and each element contained several considerations, it was possible for students to improve or decline slightly in their performance and still achieve the same score on both writing samples.

The negative ranks (students who did better on the pre-instruction writing sample than the post-instruction writing sample) showed that nine students had negative ranks on the holistic rubric while 13 had negative ranks on the analytic rubric. It was surprising that the negative ranks were so similar, considering the widely varying results for each rubric’s positive and tied ranks. Interestingly, though, when the students who earned the negative ranks on each rubric were compared, only two of the students had negative ranks on both rubrics. This indicates how differently each rubric scored each writing sample. One explanation for this is the way the analytic rubric was weighted. For example, when a student earned a score in an area that was not weighted heavily, such as punctuation, it impacted the analytic score minimally, but punctuation had a much larger impact on the holistic rubric scoring. Conversely, when a student earned a score for a heavily weighted element, such as steps of the plant life cycle, that score had more of an effect on an analytic score than on the holistic rubric score for a similar element.

Overall, both rubrics were able to indicate that the instruction had a generally positive impact on student writing, but the rubrics did not report similar scores. The holistic rubric combined several elements together, thus it was less specific. However, it was helpful for simply showing *that* students improved. This supports research that indicates that a holistic rubric should be used for comprehensive judgements (Bargainnier, 2003; Mertler, 2000; Moskal, 2000) and that a holistic rubric gives an overall impression of how well a student did (Becker, 2011; Mertler, 2000). This is also consistent with the research presented in the review of literature when researchers used a holistic rubric to assess overall quality (see Avalos et al., 2017; Fang, 2014; Duke & Bennett-Armistead, 2003; Guthrie et al., 1998; Guthrie et al., 2004; Scannella, 1982; Varble, 1990).

Conversely, the analytic rubric was more specific, and it separated and weighted different rubric elements. Therefore, it was helpful for showing *how* students improved. This is consistent with the research presented in the review of literature which used an analytic rubric to show specific ways student writing had changed (see Bruno, 1983; Cervetti et al., 2012; Clark & Neal, 2018; Guthrie et al., 1996; Troia et al., 2009; Williams et al., 2005; Yang, 2018). The findings also support researchers' recommendations that analytic rubrics be used to identify student strengths and weaknesses (Becker, 2011; Jonsson & Svingby, 2007; Wiseman, 2012). Ultimately, the findings of this research question confirm that the purposes for using a rubric must be considered when choosing which type of rubric to use and when to use them.

Strengths and Limitations

All studies have strengths and limitations, and this study was no exception. One of the strengths of the study was that it was taking place in the same setting as a previous study. Because of this, the student participants were comfortable with the presence of the researchers in their classroom. Similarly, another strength was that the classroom teachers had previously taught the integrated instruction on the topic of living and nonliving things and teaching second graders to write compare and contrast expository text, so the transition into the integrated instruction on the topic of the plant life cycle and the sequential expository text instruction used in the study was a seamless transition for the students.

Another important strength of the study was the two rubrics that were used to examine student writing rubric scores. The holistic rubric was created by the representatives from the State Board of Education and this rubric had been used by multiple scorers over the course of many years. Additionally, information related to the validity and reliability of the holistic rubric can be found on the State Board of Education website. Moreover, a psychometric analysis in the form of a Cohen's kappa was utilized to determine the reliability of this newly created analytic rubric to ensure it was also a valid and reliable instrument. Furthermore, both rubrics were created using the ELA-CCSS writing standards as a guide. This practice ensured that the instruction matched the assessment of the instruction.

The mentor texts were another strength of the study. Textbooks are often too difficult for students in the younger grades (Atkinson et al., 2009), and therefore mentor texts were a good fit for the instruction because mentor texts can be found at varying reading levels (Fang, 2013). As suggested by Fang (2013), appropriately leveled science trade books with which students can be easily engaged were selected. These books supported student learning on a variety of subjects related to the life cycle of a plant.

Despite these strengths, there were several limitations to this study. One limitation was the short length of the study. The time constraints did not allow time for specific writing instruction to be taught for more than one session. This may have impacted the students' ability to develop the expository writing skills necessary for the writing task.

Another important limitation of the study was how the analytic rubric was weighted. The results would have been different had the rubric been weighted differently. Any change in the weighting would affect the total weighted score a student's writing received. It is important to be aware of this test bias in future research.

Another limitation pertaining to the analytic rubric was that it did not contain all the elements of writing that are part of the ELA-CCSS or expository text structure. It was simply too difficult to reliably measure some elements, and they were omitted. Had they been included these elements could have provided additional valuable information about student writing ability.

Additionally, while the mentor texts can be considered a strength of the study, they also posed a limitation. It was difficult to find mentor texts that presented the science information the students needed to develop content knowledge while also demonstrating all the elements measured by one or both rubrics. For example, several of the books demonstrated signal words and the sequential expository structure, but most did not. Additionally, none of the books demonstrated a topic introduction or a conclusion. It is important for educators to note, as emphasized by Madrazo (1997), Rice (2002), and Zygouris-Coe (2012), that mentor texts must be carefully selected.

The study was further limited by the collection of writing samples. Essentially, each writing sample collected was a first draft, as students did not have an opportunity to edit or revise their writing. Adding an editing step during the instruction and before the final data collection would give more information about students' growth and in their ability to write. This would also give an opportunity for the analytic rubric to be used as a formative assessment during the process, giving the students feedback that they could use to improve their writing.

Implications for Future Research

Our current understanding related to teaching science expository text writing can be expanded by future research that considers questions the current study did not answer. One consideration is how the participants affected the study. A future study could be performed to see the results of the instruction when used with groups of students across different grade levels, age groups, ethnicities, races, and genders. The current study was also relatively small, with only 71 participants at one suburban elementary school. A larger-scale study that encompassed more schools in various settings (rural, suburban, and urban elementary schools) would allow for broader understanding of how the instruction impacts student writing.

Another consideration is how the instruction influences the writing of students at varying ability levels. The current study did not focus upon whether greater improvement was made by struggling writers or writers who were already proficient. This information would be valuable for educators and policy makers to make decisions about how to adopt curriculum that would be most effective with students of varying ability levels.

Another important consideration is the instrumentation used, particularly the analytic rubric. Future researchers can adjust the weighting on the analytic rubric to see how that affects the results. As indicated previously, even slight changes in the weighting could have considerable impact on total scores. Furthermore, researchers could incorporate other features of expository text into the analytic rubric, such as table of contents, pictures, captions, and definitions.

Additionally, the study could be repeated using a different expository text structure. Moss (2004b) suggested that teachers teach the sequential text structure first, because it seems to be easier for young children to discern and recognize within writing. Therefore, the current study used the sequential expository structure. Other scientific topics can likewise be taught that use one of the other expository structures identified by Englert and Hiebert (1984), Armbruster et al. (1987), and Meyer and Freedle (1984): cause and effect, compare and contrast, problem and solution, and description. It would be necessary, but not difficult, to adjust the instructional procedures and materials to match those structures.

Mentor texts, particularly trade books being used as mentor texts, also need further analysis. Although Atkinson et al. (2009) provided a rubric for assessing trade books and Moss (2004b) provided a list of trade books that exemplify different text structures, these resources are over a decade old. Future research could support and update both resources. More recently, Jones et al. (2016) conducted a content analysis of mentor texts published for students in Grades K-6. This content analysis provides information for teachers to use when making decisions about which mentor texts would best support their efforts to teach children to write using the expository text structures.

Research question two also requires further study. To my knowledge, there are no studies in the research literature that also compared how two different kinds of rubrics score the same writing samples. Therefore, much more information is needed on the subject to make more conclusive recommendations.

Implications for Practitioners

Based on the results of this study, certain practices could be used by teachers to help students learn to write science expository text. First, teachers should take note that mentor text choices are important. This study confirmed the suggestion by Fang (2013) that when using trade books as mentor texts, teachers must pay careful attention to which books they select. The trade books used in the current study were valuable for presenting the accurate information the students needed to develop content knowledge, but they did not provide many, if any, models of introductions, conclusions, or the signal words and features of sequential text. Additionally, teachers should be aware that they can adapt mentor texts for instruction. For example, teachers can demonstrate adding an introduction or conclusion to a mentor text that lacks them.

Teachers should also be aware of when, how, and why they are using analytic or holistic rubrics to assess student writing. The results of this study confirm Mertler's (2000) suggestion that a holistic rubric be used at the end of a unit as a summative assessment, because it gives a general sense of improvement. The study also confirmed that while an analytic rubric does show overall sense of improvement, it is perhaps best used as a formative assessment, because it gives information about the areas in which students need improvement so teachers can make adjustments and interventions (Becker, 2011; Jonsson & Svingby, 2007; Wiseman, 2012).

Providing hands-on learning activities and using literacy as a support for that learning is also a valuable tool for teachers to help students develop content knowledge. In the current study, scores for steps of the plant life cycle indicated that this type of integrated curriculum was successful for helping students develop that understanding. Teachers cannot, however, neglect the importance of providing specific writing instruction. That has been the major limitation of previous integrated science and literacy studies. Because learning to write is so difficult, students need specific, targeted instruction.

Conclusions

The ability to write is critical in today's world (Duke, 2000; Wise, 2005). However, learning to write for a variety of purposes is very difficult, a struggle plaguing students and teachers alike. Passed a decade ago, the ELA-CCSS seek to help students learn to write for a variety of purposes and be prepared for writing in higher education and employment (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010; Fang, 2014; Kersten, 2017). These standards, however, clearly define literacy goals but do not tell teachers how to implement them into their teaching practice. Teachers report diverse approaches to teaching writing (Cutler & Graham, 2008) and continue to struggle to effectively implement the standards in ways that help students achieve these writing goals, particularly when it comes to writing expository text and how to assess the writing students produce.

It is possible to help students successfully write expository text. Of the many instructional methods found in the research literature, integrating curriculum seems to be quite promising. It is limited, however, by not focusing on writing instruction. Accordingly, this study investigated an experimental instructional method that combined integrated curriculum and specific writing instruction. This instruction helped students successfully develop enough content knowledge and writing skill to write their own sequential science expository texts on the life cycle of a plant.

This study additionally investigated the use of different rubrics to assess the students' writing. Scores from both a holistic and an analytic rubric showed the improvement in students' writing samples was statistically significant after instruction. Each rubric scored differently, however, with the holistic rubric showing general changes and the analytic rubric showing specific areas in which students changed. On average, students improved in all areas assessed (e.g., plant life cycle information and various components of writing structure and mechanics), with the exception of introductions, conclusions, and spelling.

My hope is that this study can encourage teachers to continue to find ways to successfully implement the ELA-CCSS and appropriate writing instruction in their classrooms by providing a research proven method of teaching science expository text writing. When students learn to write well, they can contribute to a literate society and we all benefit.

REFERENCES

Abtahi, Y. (2017). The 'more knowledgeable other': A necessity in the zone of proximal development? *For the Learning of Mathematics, 37*(1), 35-38. http://www.jstor.org.erl.lib.byu.edu/stable/44382744

Altman, D. G. (1999). *Practical statistics for medical research*. Chapman & Hall/CRC Press.

Armbruster, B. B., Anderson, T. H., & Ostertag, J. (1987). Does text structure/summarization instruction facilitate learning from expository text? *Reading Research Quarterly, 22*(3), 331–346. https://www.jstor.org/stable/747972

Atkinson, T. S., Matusevich, M. N., & Huber, L. (2009). Making science trade book choices for elementary classrooms. *The Reading Teacher*, *62*(6), 484–497. https://doi-org.erl.lib.byu.edu/10/1598/RT.62.6.3

Atwell, N. (1987). *In the middle: Writing, reading, and learning with adolescents.* Boynton/Cook Publishers.

Avalos, M. A., Secada, W. G., Zisselsberger, M. G., & Gort, M. (2017). "Hey! Today I will tell you about the water cycle!": Variations of language and organizational features in third-grade science explanation writing. *The Elementary School Journal, 118*(1), 149-176. https://doi.org/10.1086/692987

Bargainnier, S. (2003). Fundamentals of rubrics. In S. W. Beyerlein, C. Holmes, & D. K. Apple (Eds.) *Faculty guidebook: A comprehensive tool for improving faculty performance* (pp. 75-78). Pacific Crest.

Bartlett, A. (1994). The implications of whole language for classroom management. *Action in Teacher Education, 16*(1), 65-74. https://doi.org/10.1080/01626620.1994.10463189

Becker, A. (2011). Examining rubrics to be used to measure writing performance in U.S. intensive English programs. *CATESOL Journal, 22*(1), 113-130.

Berninger, V. W., Vaughan, K., Abbott, R. D., Begay, K., Coleman, K. B., Curtin, G., Hawkins, J. M., & Graham, S. (2002). Teaching spelling and composition alone and together: Implications for the simple view of writing. *Journal of Educational Psychology, 94*(2), 291–304. https://doi.org/10.1037/0022-0663.94.2.291

Blake, B., & Pope, T. (2008). Developmental psychology: Incorporating Piaget's and Vygotsky's theories in classrooms. *Journal of Cross-Disciplinary Perspectives in Education, 1*(1), 59-67.

Bodrova, E., & Leong, D. J. (1998). Scaffolding emergent writing in the zone of proximal development. *Literacy, Teaching, and Learning, 3*(2), 1-18.

Bollinger, A. S., & Smith, R. D. (2001). Managing organizational knowledge as a strategic asset. *Journal of Knowledge Management, 5*(1), 8-18. https://doi.org/10.1108/13673270110384365

Bomer, R. (2003). Things that make kids smart: A Vygotskian perspective on concrete tool use in primary literacy classrooms. *Journal of Early Childhood Literacy, 3*(3), 223–247. https://doi-org.erl.lib.byu.edu/10.1177/14687984030033002

Bradley, L. G., & Donovan, C. A. (2010). Information book read-alouds as models for second-grade authors. *The Reading Teacher*, *64*(4), 246–260. https://doi-org.erl.lib.byu.edu/10.1598/RT.64.4.3

Brookhart, S. M. (1999). *The art and science of classroom assessment: The missing part of pedagogy.* George Washington University, Graduate School of Education and Human Development.

Bruno, D. D. (1983). *The writing process method versus the traditional textbook-worksheet method in the teaching of composition skills to third, fourth, and fifth grade pupils* (Publication No. 8400878) [Master's thesis, University of Colorado]. ProQuest Dissertations & Theses Global.

Button, K., Johnson, M. J., & Furgerson, P. (1996). Interactive writing in a primary classroom. *The Reading Teacher, 49*(6), 446-454.

Calkins, L. M. (1986). *The art of teaching writing.* Heinemann.

Calkins, L. M., & Ehrenworth, M. (2016). Growing extraordinary writers: Leadership decisions to raise the level of writing across a school and a district. *The Reading Teacher, 70*(1), 7-18. https://doi.org/10.1002/trtr.1499

Casteel, C. P., & Isom, B. A. (1994). Reciprocal processes in science and literacy. *The Reading Teacher, 47*(7), 538-545. http://www.jstor.org/stable/20201315

Caswell, L. J., & Duke, N. K. (1998). Non-narrative as a catalyst for literacy development. *Language Arts, 75*(2), 108–117. https://www.jstor.org/stable/41962037

Cervetti, G. N., Barber, J., Dorph, R., Pearson, P. D., & Goldschmidt, P. G. (2012). The impact of an integrated approach to science and literacy in elementary school classrooms. *Journal of Research in Science Teaching*, *49*(5), 631–658. https://doi-org.erl.lib.byu.edu/10.1002/tea.21015

Cervetti, G. N., Pearson, P. D., Bravo, M. A., & Barber, J. (2005). Reading and writing in the service of inquiry-based science. In R. Douglas, M. P. Klentschy, & K. Worth (Eds.), *Linking science and literacy in the K–8 classroom* (pp. 221–244). National Science Teachers Association Press.

Chall, J. S., & Jacobs, V. A. (2003). The classic study on poor children's fourth-grade slump. *American Educator, 27*(1)*,* 14-15, 44.

Chambliss, M. J., Christenson, L. A., & Parker, C. (2003). Fourth graders composing scientific explanations about the effects of pollutants: Writing to understand. *Written Communication*, *20*(4), 426-454. https://doi-rg.erl.lib.byu.edu/10.1177/0741088303260504

Cicconi, M. (2014). Vygotsky meets technology: A reinvention of collaboration in the early childhood mathematics classroom. *Early Childhood Education Journal, 42*, 57-65. https://doi.org/10.1007/s10643-013-0582-9

Clark, S. K., Jones, C. D., & Reutzel, D. R. (2013). Using the text structures of information books to teach writing in the primary grades. *Early Childhood Education Journal, 41,* 265-271. http://dx.doi.org/10.1007/s10643-012-0547-4

Clark, S. K., Lott, K., Larese-Casanova, M., Taggart, A., & Judd, E. (2020). Leveraging disciplinary literacy to teach science informational text in first grade and to explore student perceptions of scientists. *Research in Science Education*. https://doi.org/10.1007/s11165-020-09927-9

Clark, S. K., & Neal, J. (2018) Teaching second-grade students to write sequential text. *The Journal of Educational Research, 111*(6), 764-772. https://doi.org/10.1080/00220671.2018.1437531

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Erlbaum Associates.

Cooper, C. R., & Odell, L. (1977). *Evaluating writing: Describing, measuring, judging.* National Council of English Teachers.

Creswell, J. W., & Guetterman, T. C. (2019). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Pearson Education.

Cutler, L., & Graham, S. (2008). Primary grade writing instruction: A national survey. *Journal of Educational Psychology, 100*(4), 907-919. https://doi-org.erl.lib.byu.edu/10.1037/a0012656

Daffern, T., Mackenzie, N. M., & Hemmings, B. (2017). Predictors of writing success: How important are spelling, grammar and punctuation? *Australian Journal of Education, 61*(1), 75-87. http://dx.doi.org.erl.lib.byu.edu/10.1177/0004944116685319

DePaul University. (2000). *Types of rubrics.* Teaching Commons. https://resources.depaul.edu/teaching-commons/teaching-guides/feedback-grading/rubrics/Pages/types-of-rubrics.aspx

de Oliveira, L. C., & Lan, S. W. (2014). Writing science in an upper elementary classroom: A genre-based approach to teaching English language learners. *Journal of Second Language Writing*, *25*, 23-39. https://doi.org/10.1016/j.jslw.2014.05.001

Dickinson, P., & Adams, J. (2017). Values in evaluation: The use of rubrics. *Evaluation and Program Planning, 65*(x), 113-116. https://doi.org/10.1016/j.evalprogplan.2017.07.005

Dollins, C. A. (2016). Crafting creative nonfiction: From close reading to close writing. *The Reading Teacher*, *70*(1), 49–58. https://doi-org.erl.lib.byu.edu/10.1002/trtr.1465

Dreher, M. J., & Kletzien, S. B. (2016). Have recommended book lists changed to reflect current expectations for informational text in K-3 classrooms? *Reading Psychology*, *37*(3), 371-391. https://doi.org/10.1080/02702711.2015.1055871

Duke, N. K. (2000). 3.6 Minutes per day: The scarcity of informational texts in first grade. *Reading Research Quarterly*, *35*(2), 202–224. http://www.jstor.org/stable/748074

Duke, N. K. (2004). The case for informational text. *What Research Says About Reading, 61*(6), 40-44.

Duke, N. K., & Bennett-Armistead, V. S. (2003). *Reading and writing informational text in the primary grades: Research-based practices.* Scholastic Teaching Resources.

Duke, N. K., & Kays, J. (1998). ‘‘Can I say ‘once upon a time’?’’: Kindergarten children developing knowledge of information book language. *Early Childhood Research Quarterly, 13*(2), 295–318. https://doi.org/10.1016/S0885-2006(99)80041-6

Eberhard, S. (2012, March 14). *How a seed grows* [Video]. YouTube. https://www.youtube.com/watch?v=czRUxCJwVjw.

Ehowgarden. (2013, August 28). *Germination of bean seeds without soil: Garden seed starting* [Video]. YouTube. https://www.youtube.com/watch?v=8QXF-6zXHfU

Emig, J. (1977). Writing as a mode of learning. *College Composition and Communication, 28*(2), 122-128. https://www.jstor.org/stable/356095

Englert, C. S., & Hiebert, E. (1984). Children’s developing awareness of text structures in expository materials. *Journal of Educational Psychology, 76*(1), 65–74.

Englert, C. S., Okolo, C. M., & Mariage, T. V. (2009). Informational writing across the curriculum. In G. A. Troia (Ed.), *Instruction and assessment for struggling writers: evidence-based practices* (pp. 139-164). Guilford Press.

Everson, B. J. (1991). Vygotsky and the teaching of writing. *Quarterly of the National Writing Project and the Center for the Study of Writing and Literacy*, *13*(3), 8–11. https://archive.nwp.org/cs/public/download/nwp_file/789/Vygotsky.pdf?x-r=pcfile_d

Fang, Z. (2005). Science literacy: A systemic functional linguistics perspective. *Science Education*, *89*, 335–347. https://doi-org.erl.lib.byu.edu/10.1002/sce.20050

Fang, Z. (2013). Disciplinary literacy in science: Developing science literacy through trade books. *Journal of Adolescent & Adult Literacy, 57*(4), 274-278. http://www.jstor.org/stable/24034680

Fang, Z. (2014). Writing a report: A study of preadolescents' use of informational language. *Linguistics and the Human Sciences*, *10*(2), 103–131. https://doi-org.erl.lib.byu.edu/10.1558/lhs.v10.2.28556

Festas, I., Oliveira, A. L., Rebelo, J. A., Damião, M. H., Harris, K. & Graham, S. (2015). Professional development in self-regulated strategy development: Effects on the writing performance of eighth grade Portuguese students. *Contemporary Educational Psychology, 40*, 17-27. https://doi.org/10.1016/j.cedpsych.2014.05.004

Fitzgerald, J., & Shanahan, T. (2000). Reading and writing relations and their development. *Educational Psychologist*, *35*(1), 39–50. https://doi-org.erl.lib.byu.edu/10.1207/S15326985EP3501_5

French, L. (2004). Science as the center of a coherent, integrated early childhood curriculum. *Early Childhood Research Quarterly, 19*(1), 138-149. https://doi.org/10.1016/j.ecresq.2004.01.004

Funk, G., & Funk, H. (1989). Roadblocks to implementing the writing process. *The Clearing House, 62*(5), 222-224. Retrieved March 7, 2020, from www.jstor.org/stable/30196919

Funsciencedemos. (2017, April 5). *Seeds and the life cycle of plants* [Video]. YouTube. https://www.youtube.com/watch?v=KPKM2uc2VNo

Furey, W. M., Marcotte, A. M., Wells, C. S., & Hintzel, J. M. (2017). The effects of supplemental sentence-level instruction for fourth-grade students identified as struggling writers. *Reading and Writing Quarterly, 33*(6), 563-578. https://doi.org/10.1080/10573569.2017.1288591

Furner, J., & Kumar, D. (2007). The mathematics and science integration argument: A stand for teacher education. *Eurasia Journal of Mathematics, Science & Technology, 3*(3), 185–189. https://doi.org/10.12973/ejmste/75397

Gallimore, R., & Tharp, R. G. (1990). Teaching mind and society: A theory of education and schooling. In L. C. Moll (Ed.) *Vygotsky and education: Instructional implications and applications of sociohistorical psychology* (pp. 175-205). Cambridge University Press.

Gibson, S. A. (2008). Guided writing lessons: Second-grade students' development of strategic behavior. *Reading Horizons*, *48*(2), 111–132.

Gilbert, J. & Graham, S. (2010). Teaching writing to elementary students in grades 4 – 6: A national survey. *The Elementary School Journal, 110*(4), 494-518. https://doi.org/10.1086/651193

Glick, J. (2004). The history of the development of higher mental functions. In R. W. Rieber & D. K. Robinson (Eds.) *The essential Vygotsky* (345-357). Kluwer Academic/Plenum Publishers.

Goatley, V. (2012). Slicing and dicing the ELA common core standards. *Principal*, *92*(1), 16–21.

Graham, S., Berninger, V., & Abbott, R. (2012). Are attitudes toward writing and reading separable constructs? A study with primary grade children. *Reading & Writing Quarterly*, *28*(1), 51–69. https://doi.org/10.1080/10573569.2012.632732

Graham, S., Bolinger, A., Olson, C., D'Aoust, C. MacArthur, C., McCutchen, D. & Olinghouse, N. (2012). *Teaching elementary school students to be effective writers: A practice guide*. National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. http://ies.ed.gov/ncee/wwc/PracticeGuide.aspx?sid=17

Graham, S., Harris, K. R., Fink-Chorzempa, B., & MacArthur, C. (2003). Primary grade teachers' instructional adaptations for struggling writers: A national survey. *Journal of Educational Psychology*, *95*(2), 279–292. https://doi-org.erl.lib.byu.edu/10.1037/0022-0663.95.2.279

Graham, S., Harris, K. R., & Mason, L. (2005). Improving the writing performance, knowledge, and self-efficacy of struggling young writers: The effects of self-regulated strategy development. *Contemporary Educational Psychology, 30*(2), 207–241. https://doi.org/10.1016/j.cedpsych.2004.08.001

Graham, S., Harris, K. R., & Santangelo, T. (2015). based writing practices and the common core: Meta-analysis and meta-synthesis. *The Elementary School Journal*, *115*(4), 498-522. https://doi.org/10.1086/681964

Graham, S., & Perin, D. (2007). A meta-analysis of writing instruction for adolescent students. *Journal of educational psychology*, *99*(3), 445. https://doi.org/10.1037/0022-0663.99.3.445

Graham, S., & Sandmel, K. (2011). The process writing approach: A meta-analysis. *The Journal of Educational Research, 104*(6), 396–407. https://doi.org/10.1080/00220671.2010.488703

Graves, D. H. (1983). *Writing: Teachers and children at work*. Heinemann Educational Books.

Grysko, R. A., & Zygouris-Coe, V. V. I. (2019). Supporting disciplinary literacy and science learning in grades 3–5. *The Reading Teacher, 73*(4). https://doi.org/10.1002/trtr.1860

Guthrie, J. T., & Alao, S. (1997). Designing contexts to increase motivations for reading. *Educational Psychologist, 32*(2), 95-105. https://doi.org/10.1207/s15326985ep3202_4

Guthrie, J. T., Bennett, L., & McGough, K. (1994). *Concept-oriented reading instruction: An integrated curriculum to develop motivations and strategies for reading* (Report No. 10). National Reading Research Center. https://files.eric.ed.gov/fulltext/ED366927.pdf

Guthrie, J. T., McRae, A., & Klauda, S. (2007). Contributions of concept-oriented reading instruction to knowledge about interventions for motivations in reading. *Educational Psychologist*, *42*(4), 237–250. https://doi-org.erl.lib.byu.edu/10.1080/00461520701621087

Guthrie, J., Van Meter, P., Hancock, G., McCann, A., Anderson, E., & Alao, S. (1998). Does concept-oriented reading instruction increase strategy use and conceptual learning from text? *Journal of Educational Psychology*, *90*(2), 261–278. https://doi-org.erl.lib.byu.edu/10.1037/0022-0663.90.2.261

Guthrie, J. T., Van Meter, P., McCann, A., Wigfield, A., Bennett, L., Poundstone, C., Rice, M., Faibisch, F., Hunt, B., & Mitchell, A. (1996). Growth of literacy engagement: Changes in motivations and strategies during concept-oriented reading instruction. *Reading Research Quarterly, 31*(3), 306-332. https://doi.org/10.1598/RRQ.31.3.5

Guthrie, J. T., Wigfield, A., Barbosa, P., Perencevich, K. C., Taboada, A., Davis, M. H., Scafiddi, N. T., & Tonks, S. (2004). Increasing reading comprehension and engagement through concept-oriented reading instruction. *Journal of Educational Psychology, 96*(4), 403–423. https://doi-org.erl.lib.byu.edu/10.1037/0022-0663.96.3.403

Guthrie, J. T., Wigfield, A., & VonSecker, C. (2000). Effects of integrated instruction on motivation and strategy use in reading. *Journal of Educational Psychology*, *92*(2), 331–341. https://doi-org.erl.lib.byu.edu/10.1037/0022-0663.92.2.331

Hall, K. M., & Sabey, B. L. (2007). Focus on the facts: Using informational texts effectively in early elementary classrooms. *Early Childhood Education Journal, 35*(3), 261-268. https://doi.org/10.1007/s10643-007-0187-2

Hall-Kenyon, K., & Black, S. (2010). Learning from expository texts: Classroom-based strategies for promoting comprehension and content knowledge in the elementary grades. *Topics in Language Disorders, 30*(4), 339-349. https://doi.org/10.1097/TLD.0b013e3181ff21ea

Hammerberg, D. (2001). Reading and writing "hypertextually": Children's literature, technology, and early writing instruction. *Language Arts, 78*(3), 207-216. Retrieved February 22, 2020, from www.jstor.org/stable/41483140

Hancock, M. R. (2008). *Celebration of literature and response: Children, books, and teachers in K-8 classrooms* (3rd ed.). Pearson Prentice Hall.

Hand, B., Lawrence, C., & Yore, L. D. (1999). A writing in science framework designed to enhance science literacy. *International Journal of Science Education, 21*(10), 1021-1035. https://doi.org/10.1080/095006999290165

Hand, B., Prain, V. & Wallace, C. (2002) Influences of writing tasks on students' answers to recall and higher-level test questions. *Research in Science Education, 32*, 19-34. https://doi.org/10.1023/A:1015098605498

Harris, K. R., Graham, S., & Mason, L. H. (2003). Self-regulated strategy development in the classroom: Part of a balanced approach to writing instruction for students with disabilities. *Focus on Exceptional Children, 35*(7), 1–16. https://doi.org/10.17161/foec.v35i7.6799

Harris, K., Graham, S., & Mason, L. (2006). Improving the writing, knowledge, and motivation of struggling young writers: Effects of self-regulated strategy development with and without peer support. *American Educational Research Journal, 43*(2), 295-340. http://www.jstor.org/stable/3699421

Hebert, M., Bohaty, J. J., Nelson, J. R., & Roehling, J. V. (2018). Writing informational text using provided information and text structures: An intervention for upper elementary struggling writers. *Reading and Writing*, *31*(9), 2165-2190. https://doi-org.erl.lib.byu.edu/10.1007/s11145-018-9841-x

Hedegaard, M. (1996). The zone of proximal development as basis for instruction. In H. Daniels (Ed.), *An introduction to Vygotsky* (pp. 171-195). Routledge.

Helsel, L., & Greenberg, D. (2007). Helping struggling writers succeed: A self-regulated strategy instruction program. *The Reading Teacher, 60*(8), 752–760. https://doi.org/10.1598/RT.60.8.5

Herrington, J., & Kervin, L. (2007). Authentic learning supported by technology: Ten suggestions and cases of integration in classrooms. *Educational Media International*, *44*(3), 219-236. https://doi.org/10.1080/09523980701491666

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational technology research and development*, *48*(3), 23-48. https://doi.org/10.1007/BF02319856

Hodges, T. S. (2017) Theoretically speaking: An examination of four theories and how they support writing in the classroom. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 90*(4), 139-146. https://doi.org/10.1080/00098655.2017.1326228

Hodges, T. S., & Matthews, S. D. (2017). Picture books aren't just for kids! Modeling text structures through nonfiction mentor books. *Voices from the Middle, 24*(4), 74-79.

Huong, L. P. H. (2007). The more knowledgeable peer, target language use, and group participation. *The Canadian Modern Language Review, 64*(2), 333-354. https://doi.org/10.3138/cmlr.64.2.329

Imbrenda, J. P. (2016). The blackbird whistling or just after? Vygotsky's tool and sign as an analytic for writing. *Written Communication, 33*(1), 68–91. https://doi.org/10.1177/0741088315614582

Jaus, H. H. (1990). Science writing suggestions from the competition judges: Science and writing. *Science Activities*, *27*(4), 30–33.

Jones, C. D., Reutzel, D. R., & Fargo, J. D. (2010). Comparing two methods of writing instruction: Effects on kindergarten students' reading skills. *The Journal of Educational Research*, *103*(5), 327–341. https://doi.org/10.1080/00220670903383119

Jones, C. D., Clark, S. K., & Reutzel, D. R. (2016). Teaching text structure: Examining the affordances of children's informational texts. *The Elementary School Journal*, *117*(1), 143-169. https://doi.org/10.1086/687812

Jonsson, A., & Svingby, G. (2007). The use of scoring rubrics: Reliability, validity, and educational consequences. *Educational Research Review, 2*(2), 130-144. https://doi.org/10.1016/j.edurev.2007.05.002

Kamberelis, G. (1999). Genre development and learning: Children writing stories, science reports, and poems. *Research in the Teaching of English, 33*(4), 403-460. https://www.jstor.org/stable/40171463

Kelly G. J. (2015) Discourse in science learning. In R. Gunstone (Ed.), *Encyclopedia of science education.* Springer, Dordrecht. https://doi.org/10.1007/978-94-007-2150-0_107

Kersten, S. (2017). Becoming nonfiction authors: Engaging in science inquiry. *The Reading Teacher*, *71*(1), 33-41. https://doi-org.erl.lib.byu.edu/10.1002/trtr.1577

Kozulin, A. (2002). Sociocultural theory and the mediated learning experience. *School Psychology International, 23*(1), 7–35. https://doi.org/10.1177/0143034302023001729

Kuzon, W. M., Jr., Urbanchek, M. G., & McCabe, S. (1996). The seven deadly sins of statistical analysis. *Annals of Plastic Surgery, 37*, 265–272. https://doi.org/10.1097/00000637-199609000-00006

Kvålseth, T. O. (1989). Note on Cohen's Kappa. *Psychological Reports*, *65*(1), 223–226. https://doi.org/10.2466/pr0.1989.65.1.223

Li, D., Beecher, C., & Cho, B.-Y. (2018). Examining the reading of informational text in 4th grade class and its relation with students' reading performance. *Reading Psychology*, *39*(1), 1–28. https://doi-org.erl.lib.byu.edu/10.1080/02702711.2017.1361493

Lienemann, T. O., Graham, S., Leader-Janssen, B., & Reid, R. (2006). Improving the writing performance of struggling writers in second grade. *The Journal of Special Education, 40*(2), 66-78. https://doi.org/10.1177/00224669060400020301

Madrazo, G. M., Jr. (1997). Using trade books to teach and learn science. *Science and Children, 34*(6), 20.

Magnusson, S. J., & Palincsar, A. S. (1995). The learning environment as a site of science education reform. *Theory Into Practice*, *34*(1), 43-50. https://doi-org.erl.lib.byu.edu/10.1080/00405849509543655

Maloch, B. (2008). Beyond exposure: The uses of informational texts in a second grade classroom. *Research in the Teaching of English, 42*(3), 315-362. http://www.jstor.org/stable/40171756

Maloch, B., & Bomer, R. (2013). Teaching about and with informational texts: What does research teach us? *Language Arts*, *90*(6), 441-450. www.jstor.org/stable/24575004

Mantzicopoulos, P., & Patrick, H. (2011). Reading picture books and learning science: Engaging young children with informational text. *Theory Into Practice*, *50*(4), 269–276. https://doi.org/10.1080/00405841.2011.607372

McCarrier, A., Fountas, I. C., & Pinnell, G. S. (2000). *Interactive writing: How language and literacy come together, k-2.* Heinemann.

McGee, L. M., & Richgels, D. J. (1985). Teaching expository text structure to elementary students. *The Reading Teacher, 38*(8), 739–748. https://www.jstor.org/stable/20198920

McHugh, M. L. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica*, *22*(3), 276-282. https://doi.org/10.11613/BM.2012.031

McLurkin, D. (2003). Teaching children to compose informational text. In N. K. Duke & V. S. Bennett-Armistead (Eds.), *Reading and writing informational text in the primary grades: Research-based practices* (pp. 127-156). Scholastic Teaching Resources.

Mertler, C. A. (2000). Designing scoring rubrics for your classroom. *Practical Assessment, Research, and Evaluation*, *7*(1), 276-282. https://doi.org/10.7275/gcy8-0w24

Meyer, B. J., & Freedle, R. O. (1984). Effects of discourse type on recall. *American Educational Research Journal, 21*(1), 121–143. https://doi.org/10.3102/00028312021001121

Meyer, B. J. F., & Wijkumar, K. (2007). A web-based tutoring system for the structure strategy: Theoretical background, design, and findings. In D. S. McNamara (Ed.), *Reading comprehension strategy: Theories, interventions, and technologies* (pp. 347–374). Lawrence Erlbaum.

Mo, Y., Kopke, R. A., Hawkins, L. K., Troia, G. A., & Olinghouse, N. G. (2014). The neglected "r" in a time of common core. *The Reading Teacher, 67*(6), 445-453. https://doi.org/10.1002/trtr.1227

Morphy, P., & Graham, S. (2012). Word processing programs and weaker writers/readers: A meta-analysis of research findings. *Reading and Writing, 25*(3), 641–678. https://doi.org/10.1007/s11145-010-9292-5

Moskal, B. M. (2000). Scoring rubrics: What, when and how? *Practical Assessment, Research, and Evaluation, 7*(3), 1-5. https://doi.org/10.7275/a5vq-7q66

Moss, B. (1997). A qualitative assessment of first graders' retelling of expository text. *Reading Research and Instruction, 37*(1), 1–13. https://doi.org/10.1080/19388079709558251

Moss, B. (2004a). Fabulous, fascinating fact books: Using informational trade books as models for kids' writing can yield rich results. *Instructor, 113*(8), 28–29,65.

Moss, B. (2004b). Teaching expository text structures through information trade book retellings. *The Reading Teacher*, *57*(8), 710–718. https://www.jstor.org/stable/20205422

National Commission on Writing in America's Schools and Colleges. (2003). *The neglected "R": The need for a writing revolution*. College Entrance Examination Board. Retrieved March 7, 2020, from http://www.vantage.com/pdfs/neglectedr.pdf

National Commission on Writing in America's Schools and Colleges. (2004). *Writing: A ticket to work. . . or a ticket out. A survey of business leaders*. College Entrance Examination Board. Retrieved February 8, 2020, from http://ltwfiles.s3.amazonaws.com/pdf/writing-ticket-to-work.pdf

National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). *Common core state standards for English language arts and literacy in history/social studies, science, and technical subjects*. National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington, DC.

Ness, M. (2011). Teachers' use of and attitudes toward informational text in k-5 classrooms. *Reading Psychology*, *32*(1), 28–53. https://doi-org.erl.lib.byu.edu/10.1080/02702710903241322

Nicolau, J. L., Mellinas, J. P., & Martin-Fuentas, E. (2020). The halo effect: A longitudinal approach. *Annuls of Tourism Research, 83,* 1-10. https://doi.org/10.1016/j.annals.2020.102938

Nordlof, J. (2014). Vygotsky, scaffolding, and the role of theory in writing center work. *Writing Center Journal*, *34*(1), 45-64. https://www.jstor.org/stable/43444147

Nurfaidah, S. (2018). Vygotsky's legacy on teaching and learning writing as a social process. *LANGKAWI: Journal of The Association for Arabic and English, 4*(2), 149-156. http://dx.doi.org/10.31332/lkw.v4i2.1038

Ødegaard, M., Haug, B., Mork, S. M., & Sørvik, G. O. (2014). Challenges and support when teaching science through an integrated inquiry and literacy approach. *International Journal of Science Education*, *36*(18), 2997-3020. https://doi.org/10.1080/09500693.2014.942719

Palincsar, A. S., Collins, K. M., Marano, N. L., & Magnusson, S. J. (2000). Investigating the engagement of students with learning disabilities in guided inquiry science teaching. *Language, Speech, and Hearing Services in Schools, 31*(3), 240-251. https://doi.org/10.1044/0161-1461.3103.240

Palincsar, A. S., Magnusson, S. J., Collins, K. M., & Cutter, J. (2001). Making science accessible to all: Results of a design experiment in an inclusive classroom. *Learning Disability Quarterly, 24*(1)*,* 15-32. https://doi.org/10.2307/1511293

Palincsar, A. S., Magnusson, S. J., Cutter, J., & Vincent, M. (2002). Supporting guided-inquiry instruction. *Teaching Exceptional Children*, *34*(3), 88-91.

Pappas, C. C. (1993). Is narrative "primary?" some insights from kindergarteners' pretend readings of stories and information books. *Journal of Reading Behavior, 25*(1), 97–129. https://doi.org/10.1080/10862969309547803

Pappas, C. C. (2006). The information book genre: Its role in integrated science literacy research and practice. *Reading Research Quarterly, 41*(2), 226-250. https://doi.org/10.1598/RRQ.41.2.4

Pate, P., Homestead, E., & McGinnis, K. (1993). Designing rubrics for authentic assessment. *Middle School Journal, 25*(2), 25-27. Retrieved September 5, 2020, from http://www.jstor.org/stable/23024044

Patrick, H., Mantzicopoulos, M., & Samarapungavan, A. (2009). Motivation for learning science in kindergarten: Is there a gender gap and does integrated inquiry and literacy instruction make a difference. *Journal of Research in Science Teaching, 46*(2), 166-191. https://doi-org.erl.lib.byu.edu/10.1002/tea.20276

Pearson, P. D., Moje, E., & Greenleaf, C. (2010). Literacy and science: Each in the service of the other. *Science, 328*(5977), 459-463. https://doi.org/10.1126/science.1182595

Pollington, M. F., Wilcox, B., & Morrison, T. G. (2001). Self-perception in writing: The effects of writing workshop and traditional instruction on intermediate grade students. *Reading Psychology, 22*(4), 249–265. https://doi.org/10.1080/02702710127640

Purcell-Gates, V., Duke, N. K., & Martineau, J. (2007). Learning to read and write genre-specific text: Roles of authentic experience and explicit teaching. *Reading Research Quarterly, 42*(1), 8-45. www.jstor.org/stable/4151702

Pytash, K. E., & Morgan, D. N. (2014). Using mentor texts to teach writing in science and social studies. *The Reading Teacher*, *68*(2), 93–102. https://doi-org.erl.lib.byu.edu/10.1002/trtr.1276

Read, S. (2005). First and second graders writing informational text. *The Reading Teacher*, *59*(1), 36-44. https://doi.org/10.1598/RT.59.1.4

Read, S., Reutzel, D. R., & Fawson, P. C. (2008). Do you want to know what I learned? Using informational trade books to teach text structure. *Early Childhood Education Journal, 36*(3), 213-219. https://doi-org.erl.lib.byu.edu/10.1007/s10643-008-0273-0

Repaskey, L. L., Schumm, J., & Johnson, J. (2017). First and fourth grade boys' and girls' preferences for and perceptions about narrative and expository text. *Reading Psychology 38*(8), 808-847. https://doi.org/10.1080/02702711.2017.1344165

Rice, D. (2002). Using trade books in teaching elementary science: Facts and fallacies. *The Reading Teacher, 55*(6), 552-565. http://www.jstor.org/stable/20205097

Richards, S., Sturm, J. M., & Cali, K. (2012). Writing instruction in elementary classrooms: Making the connection to common core state standards. *Seminars in Speech and Language, 30*(2), 130-145. http://dx.doi.org/10.1055/s-0032-1310313

Romance, N. R., & Vitale, M. R. (2001). Implementing an in-depth expanded science model in elementary schools: Multi-year findings, research issues, and policy implications. *International Journal of Science Education, 23*(4), 373-404. https://doi.org/10.1080/09500690116738

Romance, N. R., & Vitale, M. R. (2008, November 12). *Perspectives for improving school instruction and learning: An interdisciplinary model for integrating science and reading in grades k-5* [Paper presentation]. University of Chicago-Committee on Education Workshop on Education Lecture Series, Chicago, IL, United States. http://www.scienceideas.org/pubs-pres/articles-instructionalmodel/Improving-School-Learning-Instruction.pdf

Rosebery, A., Warren, B., & Conant, F. (1992). Appropriating scientific discourse: Findings from language minority classrooms. *The Journal of the Learning Sciences, 2*(1), 61-94. Retrieved June 12, 2020, from www.jstor.org/stable/1466685

Rowan, K. E. (1990). Cognitive correlates of explanatory writing skill: An analysis of individual differences. *Written Communication*, *7*(3), 316-341. https://doi-org.erl.lib.byu.edu/10.1177/0741088390007003002

Sackett Catalogue of Bias Collaboration, Spencer, E. A., Mahtani, K. (2017). *Hawthorne Effect.* In *Catalogue of bias*. https://catalogofbias.org/biases/hawthorne-effect/

Santangelo, T., Harris, K. R., & Graham, S. (2007). Self-regulated strategy development: A validated model to support students who struggle with writing. *Learning Disabilities: A Contemporary Journal*, *5*(1), 1–20.

Sato, T. (1996) Type I and type II error in multiple comparisons. *The Journal of Psychology, 130*(3), 293-302. https://doi.org/10.1080/00223980.1996.9915010

Scannella, A. M. (1982). *A writing-as-process model as a means for improving compositions and attitudes toward composition in the high school* (Publication No. 8301605) [Doctoral dissertation, Rutgers The State University of New Jersey]. ProQuest Dissertations & Theses Global.

SciShow Kids. (2015, June 22). *How does a seed become a plant?* [Video]. YouTube. https://www.youtube.com/watch?v=tkFPyue5X3Q

Scott, S. E., & Palincsar, A. S. (2009). Sociocultural theory. In *Psychology of classroom learning: An encyclopedia* (Vol. 2, pp. 851-856). Gale Cengage Learning.

Shanahan, T. (2015a). Common core state standards: A new role for writing. *The Elementary School Journal, 115(*4), 464-479. https://www.jstor.org/stable/10.1086/681130

Shanahan, T. (2015b). What teachers should know about common core: A guide for the perplexed. *The Reading Teacher, 68*(8), 583-588. https://doi.org/10.1002/trtr.1368

Shanahan, C., & Shanahan, T. (2014). Does disciplinary literacy have a place in elementary school? *The Reading Teacher*, *67*(8), 636-639. https://doi.org/10.1002/trtr.1257

Shanahan, T., & Shanahan, C. (2008). Teaching disciplinary literacy to adolescents: Rethinking content-area literacy. *Harvard Educational Review, 78*(1), 40-59. https://doi.org/10.17763/haer.78.1.v62444321p602101

Shanahan, T., & Shanahan, C. (2012). What is disciplinary literacy and why does it matter? *Topics in Language Disorders*, *32*(1), 7–18. https://doi.org/10.1097/TLD.0b013e318244557a

Smolkin, L. B., McTigue, E. M., Donovan, C. A., & Coleman, J. M. (2008) Explanation in science trade books recommended for use with elementary students. *Science Education, 93*(4), 587-610. https://doi-org.erl.lib.byu.edu/10.1002/sce.20313

Steele, V. (2004). Product and process writing: A comparison. *Teaching English*. https://www.teachingenglish.org.uk/article/product-process-writing-a-comparison

Stevens, S. S. (1946). On the theory of scales of measurement. *Science, 103*(2684), 677–680. https://www.jstor.org/stable/1671815

Stewart, M., & Young, T. A. (2018). Defining and describing expository literature. In V. Yenika-Agbaw, R. M. Lowery, & L. A. Hudock (Eds.), *Does nonfiction equate truth? Rethinking disciplinary boundaries through critical literacies* (pp. 11-24). Roman & Littlefield.

Stoddart, T., Pinal, A., Latzke, M., & Canaday, D. (2002). Integrating inquiry science and language development for English language learners. *Journal of Research in Science Teaching*, *39*(8), 664-687. https://doi-org.erl.lib.byu.edu/10.1002/tea.10040

Supovitz, J. A., Poglinco, S. M., & Bach, A. J. (2002). Implementation of the America's choice literacy workshops. *CPRE Research Reports*. http://repository.upenn.edu/cpre_researchreports/24

Swedish Nature and City. (2016, October 3). *[Full] Pumpkin growth time lapse: From seed to the mature fruit in 108 days and nights* [Video]. YouTube. https://www.youtube.com/watch?v=ytMpE6fubSQ

Tidwell, D. L., & Stele, J. L. (1992). *I teach what I know: An examination of teachers' beliefs about whole language* [Paper presentation]. 42nd Annual Meeting of the National Reading Conference, San Antonio, TX, United States. https://eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=ED374391

Thompson, I. (2013). The mediation of learning in the zone of proximal development through a co-constructed writing activity. *Research in the Teaching of English, 47*(3), 247-276. Retrieved June 16, 2020, from www.jstor.org/stable/24397856

Troia, G. A., Lin, S. C., Monroe, B. W., & Cohen, S. (2009). The effects of writing workshop instruction on the performance and motivation of good and poor writers. In G. A. Troia (Ed.) *Instruction and assessment for struggling writers: Evidence-based practices* (pp. 77-112). The Guilford Press.

Troia, G. A., & Olinghouse, N. G. (2013). The common core state standards and evidence-based educational practices: The case of writing. *School Psychology Review*, *42*(3), 343–357. https://doi.org/10.1080/02796015.2013.12087478

Vanderburg, R. M. (2006). Reviewing research on teaching writing based on Vygotsky's theories: What we can learn. *Reading & Writing Quarterly, 22*(4), 375-393. https://doi.org/10.1080/10573560500455778

Varble, M. E. (1990). Analysis of writing samples of students taught by teachers using whole language and traditional approaches. *The Journal of Educational Research*, *83*(5), 245-251. https://doi.org/10.1080/00220671.1990.10885965

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Harvard University Press.

Weiss, I. (2006). Professional development and strategic leadership to support effective integration of science and literacy. In R. Douglas, M. P. Klentschy, & K. Worth (Eds.) *Linking science & literacy in the K-8 classroom* (pp. 95-116). NSTA Press.

Wells, G. (1994). *Learning and teaching "scientific concepts": Vygotsky's ideas revisited* [Paper Presentation]. Vygotsky and the Human Sciences, Moscow, Russia. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.569.1169&rep=rep1&type=pdf

Wertsch, J. V. (1993). *Voices of the mind: Sociocultural approach to mediated action*. Harvard University Press.

Wilcoxon signed-rank test using SPSS statistics. (2018) *Laerd Statistics.* Retrieved May 18, 2020, from https://statistics.laerd.com/spss-tutorials/wilcoxon-signed-rank-test-using-spss-statistics.php

Williams, J. P., Hall, K. M., Lauer, K. D., Stafford, K. B., DeSisto, L. A., & deCani, J. S. (2005). Expository text comprehension in the primary grade classroom. *Journal of Educational Psychology, 97*(4), 538–550. https://doi-org.erl.lib.byu.edu/10.1037/0022-0663.97.4.538

Wise, K. (2005). The importance of writing skills. *Public Relations Quarterly, 50*(2), 37-40,48.

Wiseman, C. S. (2012). A comparison of the performance of analytic vs. holistic scoring rubrics to assess L2 writing. *Iranian Journal of Language Testing, 2*(1), 59-92.

Wolbers, K. A., Dostal, H. M., Graham, S., Cihak, D., Kilpatrick, J. R., Saulsburry, R. (2015). The writing performance of elementary students receiving strategic and interactive writing instruction. *The Journal of Deaf Studies and Deaf Education, 20*(4), 385-398. https://doi.org/10.1093/deafed/env022

Wolf, K., & Stevens, E. (2007). The role of rubrics in advancing and assessing student learning. *Journal of Effective Teaching, 7*(1), 3–14.

Wright, T. S., & Gotwals, A. W. (2017a). Supporting disciplinary talk from the start of school: Teaching students to think and talk like scientists. *The Reading Teacher, 71*(2), 189-197. https://doi-org.erl.lib.byu.edu/10.1002/trtr.1602

Wright, T. S., & Gotwals, A. W. (2017b). Supporting kindergarteners' science talk in the context of an integrated science and disciplinary literacy curriculum. *The Elementary School Journal, 117*(3), 513-537. https://doi.org/10.1086/690273

Xu, M., Fralick, D., Zheng, J. Z., Wang, B., Tu, X. M., & Feng, C. (2017). The differences and similarities between two-sample *t*-test and paired *t*-test. *Shanghai Archives of Psychiatry*, *29*(3), 184–188. https://doi.org/10.11919/j.issn.1002-0829.217070

Yang, H. (2018). Influence of learner training on students' process writing in automated writing evaluation-supported class. *Multimedia-Assisted Language Learning, 21*(3), 88-114. http://journal.kamall.or.kr/wp-content/uploads/2018/10/21_3_04_Yang.pdf

Yopp, R. H., & Yopp, H. K. (2012). Young children's limited and narrow exposure to informational text*. The Reading Teacher, 65*(7), 480-490. https://doi-org.erl.lib.byu.edu/10.1002/TRTR.01072

Young, T. A. (2017). Talking with Melissa Stewart. *Book Links*, *27*(2), 31–35.

Zygouris-Coe, V. (2012). Disciplinary literacy and the common core state standards. *Topics in Language Disorders*, *32*(1), 35–50. https://doi.org/10.1097/TLD.0b013e31824561a2

References for Children's Literature

Aloian, M. (2012a). *What are Bulbs and Roots?* Crabtree Publishing Company.

Aloian, M. (2012b). *What Are Seeds?* Crabtree Publishing Company.

Aloian, M. (2012c). *What Are Stems?* Crabtree Publishing Company.

Austen, E. (2014). *Seeds.* Teacher Created Materials.

Berne, E. C. (2017). *From cone to pine tree.* Lerner Publishing Group, Inc.

Bodden, V. (2015). *Grow with me: Apple.* Creative Paperbacks.

Esbaum, J. (2009). *Seed, sprout, pumpkin, pie.* National Geographic Society.

Gibbons, G. (2018). *Flowers.* Holiday House.

Gibbons, G. (1991). *From Seed to Plant.* Holiday House.

Goodman, E. (2009). *Plant secrets.* Charlesbridge.

Hansen, G. (2016a). *Fruits.* Abdo Publishing Company.

Hansen, G. (2016b). *Stems.* Abdo Publishing Company.

Hansen, G. (2016c). *Seeds.* Abdo Publishing Company.

Kalman, B. (2007). *Plants are living things.* Crabtree Publishing Company.

Klepeis, A. (2017a). *Leaves.* Rourke Educational Media.

Klepeis, A. (2017b). *Roots.* Rourke Educational Media.

Lundgren, J. (2011). *Plant life cycles.* Rourke Educational Media.

Macaulay, K. (2013). *What Are Flowers?* Crabtree Publishing Company.

Owings, L. (2017). *From seed to cactus.* Lerner Publishing Group, Inc.

Owings, L. (2017). *From seed to cattail.* Lerner Publishing Group, Inc.

Peterson, C. (2014). *Seed, soil, sun: Earth's recipe for food.* Penguin Random House Publisher Services.

Pfeffer, W. (2004). *From seed to pumpkin.* Harper Collins Publishers, Inc.

Prokos, A. (2017). *Seed power.* Red Chair Press.

Rattini, K. B. (2014). *National geographic readers: Seed to plant.* National Geographic Children's Books.

Schuh, M. (2017a). *From seed to strawberry*. Lerner Publishing Group, Inc.

Schuh, M. (2017b). *From seed to sunflower.* Lerner Publishing Group, Inc.

Sterling, K. (2011). *Exploring Roots.* Lerner Classroom.

APPENDIX A

Writing Rubrics Used in the Studies Located in the Literature Review

Study	Study Design	Age of Participants	Type of instruction	Rubric Used
"Hey! Today I Will Tell You About the Water Cycle!" Variations of Language and Organizational Features in Third-Grade Science Explanation Writing (Avalos et al., 2017)	Cross-sectional research; mixed methods	3rd grade	Inquiry-based science integrated with math, reading, and writing	Holistic (2)
The Writing Process Method Versus the Traditional Textbook-Worksheet Method in the Teaching of Composition to Third, Fourth, and Fifth Grade Pupils (Bruno, 1983)	Experimental	3rd-5th grade	Process-oriented writing & traditional textbook-worksheet method	Analytic
The impact of an integrated approach to science and literacy in elementary school classrooms (Cervetti et al., 2012)	Experimental	4th grade	Science & Literacy Integrated approach	Analytic
Teaching second-grade students to write sequential text (Clark & Neal, 2018)	Quasi-experimental	2nd grade	Read-to-Write Strategy	Analytic
Early Literacy Project (Duke & Bennett-Armistead, 2003)	Mixed methods	1st & 2nd grade	Varied; Direct instruction of varying genres	Holistic
Writing a report: A study of preadolescents' use of informational language (Fang, 2014)	Mixed methods	3rd, 4th, 5th grade	Report writing using mentor text	Holistic
Growth of Literacy Engagement: Changes in Motivations and Strategies during Concept-Oriented Reading Instruction (Guthrie et al., 1996)	Mixed methods	3rd grade & 5th grade	Concept-Oriented Reading Instruction (CORI)	Analytic
Does Concept-Oriented Reading Instruction Increase Strategy Use and Conceptual Learning from Text? (Guthrie et al., 1998)	Quasi-experimental	3rd and 5th grade	CORI	Holistic

Study	Study Design	Age of Participants	Type of instruction	Rubric Used
Increasing Reading Comprehension and Engagement Through Concept-Oriented Reading Instruction (Guthrie et al., 2004)	Quasi-experimental	3rd grade	CORI	Holistic
Writing-as-process Model as a Means for Improving Compositions and Attitudes Towards Composition in the High School (Scannella, 1982)	Experimental	High school	Writer's Workshop	Holistic
The Effects of Writing Workshop Instruction on the Performance and Motivation of Good and Poor Writers (Troia et al., 2009)	Quasi-experimental with no control group	2nd-5th	Writer's Workshop	Analytic (2)
Analysis of writing samples of students taught by teachers using whole language and traditional approaches (Varble, 1990)	Experimental	2nd & 6th	Whole language, process-oriented	Holistic
Expository Text Comprehension (Williams et al., 2005)	Mixed methods	2nd grade	Direct instruction of Compare Contrast Text Structure	Analytic
Influence of learner training on students' process writing in automated writing evaluation-supported class (Yang, 2018)	Mixed Methods	University	Process-oriented writing	Analytic

APPENDIX B

IRB Materials and Forms

INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS

Memorandum

To: Professor Sarah Clark
Department: TED
College: EDUC
From: Sandee Aina, MPA, IRB Administrator
Bob Ridge, PhD, IRB Chair
Date: April 16, 2018
IRB#: X18059
Title: *"Determining the Effects of Two Instructional Strategies When Teaching Second Graders to Read and Write Science Informational Text"*

Brigham Young University's IRB has approved the research study referenced in the subject heading as expedited level. The approval period is from **April 16, 2018 to April 15, 2019**. Please reference your assigned IRB identification number in any correspondence with the IRB. Continued approval is conditional upon your compliance with the following requirements:

1. CONTINGENCY
   - Please revise the application so that the revisions appear in the appropriate section.
     - For example, item 10c should be: 7-9, 20-60.
     - Item 10a: Are the teachers included in the 150 target size?
   - Please note that you are given full approval once each school district provides you documentation of their approval and it is sent to the BYU IRB.
2. A copy of the informed consent statement is attached. No other consent statement should be used. Each research subject must be provided with a copy or a way to access the consent statement.

3. Any modifications to the approved protocol must be submitted, reviewed, and approved by the IRB before modifications are incorporated in the study.
4. All recruiting tools must be submitted and approved by the IRB prior to use.
5. In addition, serious adverse events must be reported to the IRB immediately, with a written report by the PI within 24 hours of the PI's becoming aware of the event. Serious adverse events are (1) death of a research participant; or (2) serious injury to a research participant.
6. All other non-serious unanticipated problems should be reported to the IRB within 2 weeks of the first awareness of the problem by the PI. Prompt reporting is important, as unanticipated problems often require some modification of study procedures, protocols, and/or informed consent processes. Such modifications require the review and approval of the IRB.
7. A few months before the expiration date, you will receive a continuing review form. There will be two reminders. Please complete the form in a timely manner to ensure that there is no lapse in the study approval.

IRB Secretary
A 285 ASB
Brigham Young University
(801)422-3606

Page 1 of 1

Approved IRB Protocol Amendment/Modification Request

Institutional Review Board

Protocol #: X18059 Date: 3/18/19

1. Title of the Study: Determining the Effects of Two Instructional Strategies When Teaching Second Graders to Read and Write Sc

2. Principal Investigator: Sarah K. Clark Title of PI: Associate Professor

Department: Teacher Education Phone: 801-422-4607 Email: sarah_clark@byu.edu

Address: 201-N MCKB, Brigham Young University

5. Correspondence Request: (•) Mail ( ) Call for Pick-up

6. Select amendment change type

- ☐ Administrative Changes
- ☒ Other:
- ☐ Consent Form Revisions
- ☐ Protocol Revisions

7. Describe the modifications requested, including reasons for the changes.

I would like to add Angenette Imbler, a graduate student, to the IRB protocol. This would enable Angenette to work with these data, possibility a portion of the data could be used for her thesis study. The data collection has already been completed.

8. Will the modifications, in your opinion, increase, decrease, or have no affect on the risk of harm to the subjects?

(•) Neither ( ) Increase ( ) Decrease

9. Will the modifications alter the approved consent form?

( ) Yes (•) No

Sarah K Clark — Signature of the Principal Investigator

3-2019 — Date

Note: Approval of this amendment does not change your protocol's expiration date.

Ver. 3/1

Parental Permission for a Minor

Introduction

My name is Sarah Clark. I am an associate professor from Brigham Young University. I am conducting a research study about which type of instruction is most helpful to young children as they learn to read and write sequential informational text. I am inviting your child to take part in the research because (he/she) is a second grader attending a public school in the ____________________ school district and attends __________________.

Procedures

The research will take place in your child's classroom and will occur during the reading and writing instruction time. Each learning session will last approximately 50 minutes with a minimum of three sessions each week over the course of four weeks. If you agree to let your child participate in this research study, the following will occur:

- Your child will be asked to provide a writing sample of sequential informational text before he or she participates in the new reading and writing instruction. Informational text is considered nonfiction text or anything that is not a story or narrative.
- Additionally, your child will also be asked to complete a pre-instruction reading motivation survey and a pre-instruction reading comprehension assessment before he or she participates in the new reading and writing instruction.
- During reading and writing instruction, your child will be taught to read and write information using Science-Infused Literacy Instruction which incorporates a variety of science investigations about the life cycle of animals and fast plants, or your child may be provided with the Read-to-Write Instruction where exemplar texts to use as models for his/her own reading and writing.
- Next, your child will submit a sequential informational text writing sample after the new instruction. We think that your child's writing from the first to the second writing sample will show an improvement in science content, text structure, number of signal words, an opening/closing statement, and an overall increase in word count.
- Finally, your child will also be asked to complete a post-instruction reading motivation survey and a post-instruction reading comprehension assessment and we anticipate there will be increases in these surveys and assessments from pre- to post-instruction as well.

Risks

Participation in this research study may involve some added risks or discomforts. These include minimal discomfort as your child attempts new reading and writing strategies. Your child may participate only in those reading, writing, and science activities that he/she wants to, or your child may stop the entire process at any time without affecting his/her standing in school or his/her grades in class. There is a small risk of loss of privacy, which the researcher will reduce by not using any real names or other identifiers in the written report or data. The researcher will also keep all data in a locked file cabinet and/or password-protected computer, both stored in a secure and locked location. Only the researchers will have access to the data. At the end of the study, data will be destroyed two years after the completion of the study.

Confidentiality

Research records will be kept confidential, consistent with federal and state regulations. To protect your child's privacy, numerical identifiers will be used. Only the researcher will have access to these data, which will be kept in a locked file cabinet and/or on a password-protected computer in a locked room at the school to maintain confidentiality. Data will be maintained for two years after data collection has been completed and then destroyed.

Institutional Review Board
4-16-2018 Approved
4-15-2019 Expires

Benefits

There are no direct benefits to your child from participating in this study. Your child's understanding of science content and concepts, reading comprehension, and ability to write sequential informational text will likely see improvement because of the extra attention and additional instruction devoted to this topic. The investigators may also learn more about effective reading and writing instruction merged with science instruction can be used when teaching young children to read and write complex informational text.

Compensation

There will be no compensation for your child's participation in this project.

Questions about the Research

Questions about your child's rights as a study participant or to submit comment or complaints about the study should be directed to the IRB Administrator, Brigham Young University, A-285 ASB, Provo, UT 84602. Call (801) 422-1461 or send emails to irb@byu.edu.

You have been given a copy of this consent form to keep.

Participation

Participation in this research study is voluntary. You are free to decline to have your child participate in this research study. You may also withdraw your child's participation at any point without affecting your child's grade/standing in school, treatment, or benefits, etc.

Child's Name: ______________________________

Parent Name: ______________________________

Signature: ______________________________

Date: ______________________________

Child Assent (7-14 years old)

What is this research about?

My name is Sarah Clark. I want to tell you about a research study I am doing. A research study is a special way to find the answers to questions. We are trying to learn more about how children should be taught to read and write books about science. You are being asked to join the study because you are a second grader attending ________________ school. If you decide you want to be in this study, this is what will happen:

- You will be asked to read some books and write a paper about science.
- You will also complete a survey with questions about how much you like to read and write.
- Your teacher will teach you about science topics (including meal worms and fast plants) and/or about how scientists write books and read books about science.
- Next, you will be asked to read more books and write more papers about science.
- You will again be asked to take the survey with questions about how much you like to read and write.

Can anything bad happen to me?

We don't think anything bad will happen. You might feel a bit uncomfortable because you are learning new things in new ways, but we will do everything we can to help you feel comfortable.

Can anything good happen to me?

We don't know if being in this study will help you. It might help you become a better reader and writer. We hope to learn something that will help other teachers and children.

Do I have other choices?

You can choose not to be in this study.

Will anyone know I am in the study?

We won't tell anyone you took part in this study. When we are done with the study, we will write a report about what we learned. We won't use your name in the report.

What happens if I get hurt?

You shouldn't get hurt by participating in this study.

What if I do not want to do this?

You don't have to be in this study. It's up to you. If you say yes now, but change your mind later, that's okay too. All you have to do is tell us.

Before you say yes to be in this study; be sure to ask Sarah Clark to tell you more about anything that you don't understand.

If you want to be in this study, please sign and print your name.

Name (Printed):____________________ Signature____________________ ________Date:

Institutional Review Board
4-16-2018 Approved 4-15-2019 Expires

APPENDIX C

Holistic Rubric

Informative Writing Rubric 2nd Grade		
Score	**Statement of Purpose / Focus and Organization (4-point rubric)**	**Conventions/Editing (2-point rubric begins at score point 2)**
4	The response is fully sustained and consistently and purposefully focused: • Strong, clear introduction to the topic • Uses 3 or more facts about the topic and interweaves them seamlessly • Provides a concluding statement or section that reiterates the key points	
3	The response is adequately sustained and generally focused: • Introduces the topic • Uses 2 or more facts and definitions to develop points • Provides a concluding statement or section	
2	The response is somewhat sustained and may have a minor drift in focus: • Unclear or unfocused topic • Confusing or irrelevant facts about the topic • Minimal or absent concluding statement or section	The response demonstrates an adequate command of conventions: • Consistent and correct use of punctuation, capitalization, and spelling • Uses a combination of simple and compound sentences. • Capitalizes the holidays, product names, and geographic names. • Uses an apostrophe for contractions and possessives • Uses commas in dates and to separate single words in a series • Uses conventional spelling for words with common spelling patterns and for frequently occurring irregular words • Some errors in usage and sentence formation are present, but no systematic pattern of errors is displayed
1	The response may be related to the topic but may provide little or no focus: • No stated topic • No facts included • No sense of closure	The response demonstrates partial command of conventions: • Errors in usage may obscure meaning • Inconsistent use of punctuation, capitalization, and spelling
0		The response demonstrates a lack of command of conventions.
NS	Insufficient, illegible, foreign language, incoherent, off topic, or off-purpose writing	

APPENDIX D

Analytic Rubric

Student ________________________________ Points _______/32 Weighted Points _______/3.8

Rubric Element	Definition	Points
Topic Introduction (see note) The topic of a plant's life cycle is introduced.	Strong, clear introduction to the topic that includes the words life, cycle, and plant. (e.g., "The life cycle of a plant" or "A plant's life cycle")	4
	Includes an introduction/ beginning sentence that addresses the topic of plants. (e.g., "How plants grow" or "All about plants")	3
	Introduction topic is incomplete.	2
	Introduction topic is incorrect.	1
	No stated topic	0
		X .15
Steps of the Plant Life Cycle Steps of the plant life cycle are included (e.g., seed, seed is nourished with soil/sun/water, seed cracks open, growth, roots, sprout, stem, leaves, flower, fruit, seeds, death).	6 or more steps of the plant life cycle included.	4
	4-5 steps of the plant life cycle included.	3
	2-3 steps of the plant life cycle included.	2
	1 step of the plant life cycle	1
	No information included.	0
		X .30
Concluding Statement A conclusion is included.	Concluding statement or section that reviews key facts included.	4
	Concluding statement or section on topic included. (e.g., That's the life cycle of a plant.)	3
	General concluding statement that indicates completion of writing included. (e.g. "The end")	2
	Concluding statement is off topic or incomplete.	1
	No concluding statement included.	0
		X .15
Signal Words to Indicate Sequence Words to signal sequence are included (e.g., first, second, third, starts, begins, then, next, following, after, last, finally, etc.)	Four or more different signal words used.	4
	Three different signal words used.	3
	Two different signal words used.	2
	One signal word used.	1
	No signal words used.	0
		X .20
Capitalization at Beginning of Sentences (see note) Sentences begin with a capital letter.	Four or more sentences begin with a capital letter.	4
	Three sentences begin with a capital letter.	3
	Two sentences begin with a capital letter.	2
	One sentence begins with a capital letter.	1
	No capitalization is used when it is needed.	0
		X .05
Ending Punctuation (see note) Sentences end correctly with a period, question mark, or exclamation point.	Four or more sentences end with correct punctuation.	4
	Three sentences end with correct punctuation.	3
	Two sentences end with correct punctuation.	2
	One sentence ends with correct punctuation.	1
	No correct ending punctuation used when it is needed/ not enough written to require punctuation.	0
		X .05

Spelling	Correct spelling throughout.	4
	1-6 spelling errors that do not obscure meaning.	3
	6 or more spelling errors that do not obscure meaning.	2
	6 or more spelling errors, and making meaning is difficult.	1
	Unreadable due to spelling errors/lack of words to score spelling.	0
		X .05
Word Count (see note) The number of words a student wrote in response to the prompt.	50 or more words	4
	36-49 words	3
	23-35 words	2
	10-22 words	1
	0-9 words	0
		X .05

Note: Title is included when scoring Topic Introduction and Word Count elements, but not when scoring Capitalization at Beginning of Sentence nor Ending Punctuation elements.

APPENDIX E

Teaching Observation Forms

Name: ____

Teacher Name: ____

Date of Lesson: ____

Title of Lesson: ____

Please answer the following questions (Feel free to add to the back of page):

1. Review the Lesson Plan. Were all planned activities complete? If not, describe which were and which were not.

2. How well are students engaged?

3. Were all materials used? If not, which were and which were not used?

4. Was there sufficient time for the lesson?

5. Other questions/comments

APPENDIX F

Instructional Procedures

Day	Instruction
1	**Teacher collects pre-instruction writing samples.**
2	**Parts of a Plant** In small groups, students are provided with a mature basil plant and encouraged to explore it using their senses (except taste) to determine the parts of the plant. Students draw and record their observations on a graphic organizer (see Appendix G - Handout 1: *Parts of a Plant*). Teacher asks questions to encourage thinking such as, "Can you see parts of plant under the plant? Gently move the soil to see what is there. What do you see? What are those parts? Name them." Students are encouraged to come up with their own labels.
3	**The Seed** Teacher distributes a bean seed to each student. Students draw the bean on the first day of the graphic organizer (see Appendix G - Handout 2: *Seed Diary*). Teacher discusses the bean seed with students by asking questions like the following, "What type of seed is it? How do you know? What will it look like as it starts to grow?" Once students have drawn a picture for the first day, they draw a picture predicting what the last day of growth will look like for the seed. Teacher then plants the bean seeds with students in a paper towel dampened with water according to video instructions (Ehowgarden, 2013) and stores these in glass jars for students to observe each day. Students draw a picture in their *Seed Diary* even on days they do not have instruction so as to capture the day-to-day progress.
4	**Gathering Evidence: What do Scientists Say About Plants?** Teacher displays the diagram of a plant with each of the parts labeled (see Appendix G - Handout 3: *Parts of a Plant*). In small groups, students are assigned a plant part (stem, leaf, flower, roots, seeds, or fruit) to research and read about. Students access books about assigned plant parts (see Aloian, 2012a, 2012b, 2012c; Austen, 2014; Gibbons, 2018; Hansen, 2016a, 2016b, 2016c; Klepeis, 2017a; 2017b; Macaulay, 2013; Sterling, 2011) digitally on Epic! (see getepic.com). They take notes as a group on a graphic organizer (see Appendix G - Handout 3: *Parts of a Plant*) and report their findings to the class. Finally, students record a sketch of their bean seed growing and record these observations for the day in their *Seed Diary.*
5	**How Pumpkins Grow** Teacher shows the students a pumpkin and explains that pumpkin is a type of plant that starts as a seed to become a full-grown plant, and the pumpkin is the fruit of the pumpkin plant. Teacher shows students the pumpkin seeds, and they discuss different ways pumpkins are grown and used. Divided into small groups, the students read books about how pumpkins grow. Half of the groups read *From Seed to Pumpkin* (Pfeffer, 2004), and the other half read *Seed, Sprout, Pumpkin, Pie* (Esbaum, 2009). Groups take notes on sticky notes while reading, and each group shares their findings with the class. Teacher shows a time-lapse video of a pumpkin seed growing (Swedish Nature and City, 2016). Finally, students observe their bean seed growing and record a new sketch of this observation in their *Seed Diary.*
6	**The Life Cycle of a Plant** Teacher shows and leads a discussion on a video about plant life cycles (SciShow Kids, 2015). In pairs, students read at least 1 book, as time allows, about plant life cycles to explore the stages of the plant life cycle (see Gibbons, 1991; Goodman, 2009; Kalman, 2007; Lundgren, 2011; Peterson, 2014; Rattini, 2014). Students access books on Epic! (see getepic.com), take notes on Handout 4 (see Appendix G-Handout 4: *From Seed to Plant*), and share their findings with the class. Teacher shows and leads a class discussion on a second video that reviews the stages of a plant's life cycle (Funsciencedemos, 2017). Finally, students observe their bean seed growing and record a new sketch of this observation in their *Seed Diary.*

Day	Instruction
7	**Life Cycle of a Bean Seed** Teacher reads *Seed Power* (Prokos, 2017) to the class and leads a discussion about the story and what seeds need to grow. They also discuss what all living things, including seeds, need for survival. Students make a final observation of their bean plant, record a final sketch in their *Seed Diary*, and compare it to their original prediction sketch. Teacher guides this comparison by asking questions such as, "How are these final sketches the same? Different? What surprised you? What grew as you expected?" Finally, teacher shows a time lapse video of a bean seed growing (Eberhard, 2012). Teacher explains that for their seed to keep growing, it needs to be planted in soil so it can gather nutrients. Until now, the seed has been using food stored inside itself to grow.
8	**Types of Seeds and Plants** In small groups, students are assigned a plant the read and research about. Students read digital books (see Berne, 2017; Bodden, 2015; Owings, 2017 a, 2017b; Schuh, 2017a, 2017b) about assigned plants on Epic! (see getepic.com), take notes as a group on sticky notes, and share what they learn with the class. Teacher leads a discussion about the different types of plants by asking questions such as, "How are the plants the same? How are they different? Do all the seeds follow the same cycle?"
9	**Read-to-Write Lesson on Sequential Text Structure** Teacher displays the PowerPoint (see Appendix G - *Writing a Sequential Text Using a Mentor Text as a Guide*). This follows the Read-to-Write Strategy (Clark et al., 2013) as seen in Figure 1 using a book about the life cycle of a chicken. Leaving the last slide on display, the class then works together to practice writing an expository text that employs the sequential text structure about the life cycle of a chicken. A different topic is used than the life cycle of plants, but the sequential text structure is the same.
10	**Teacher collects post-instruction writing samples.**

APPENDIX G

Instructional Materials

Sequence Graphic Organizer

Title of Book_______________________________________

First

Second

Third

Fourth

Finally

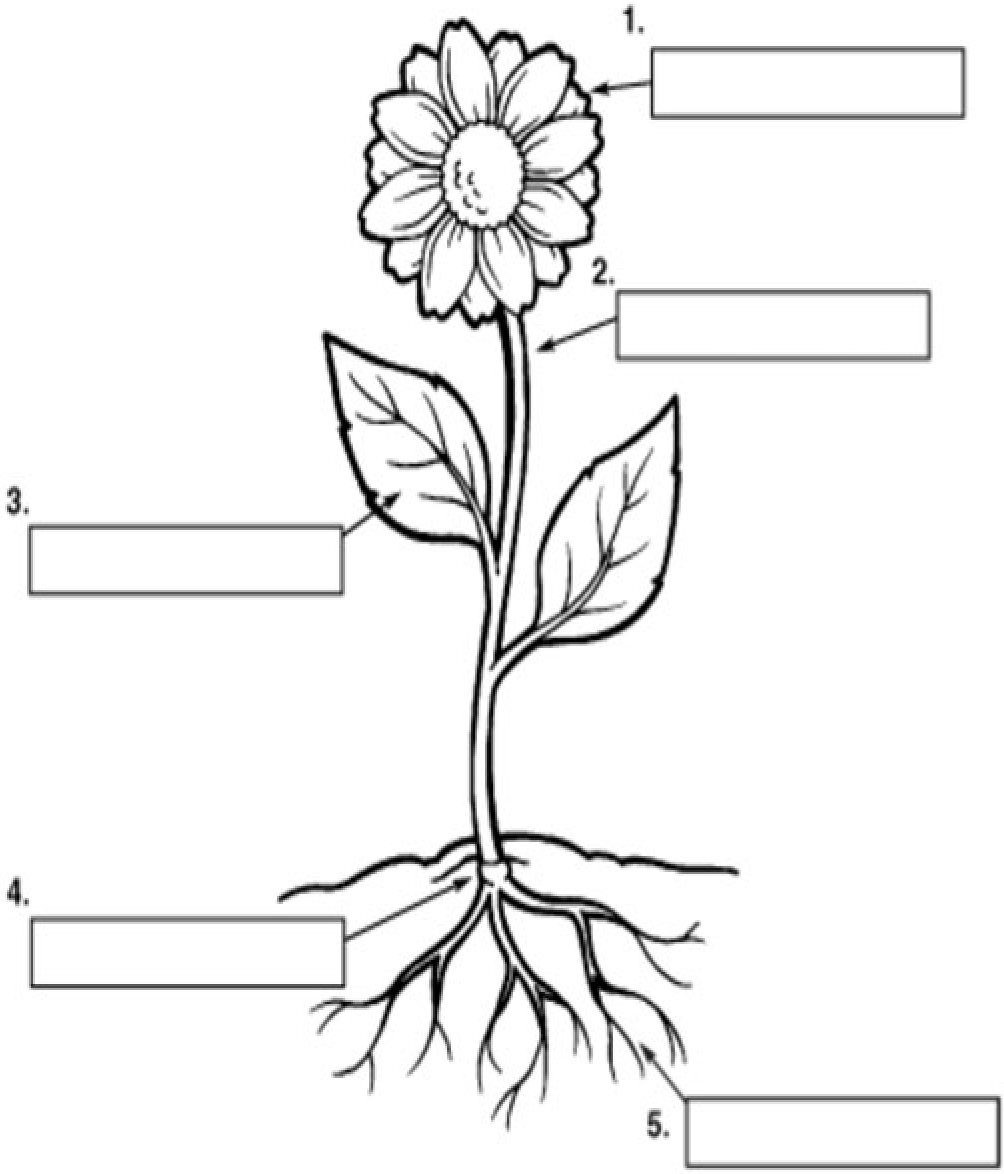
Other Signal Words

Parts of a Plant (Handout 1)

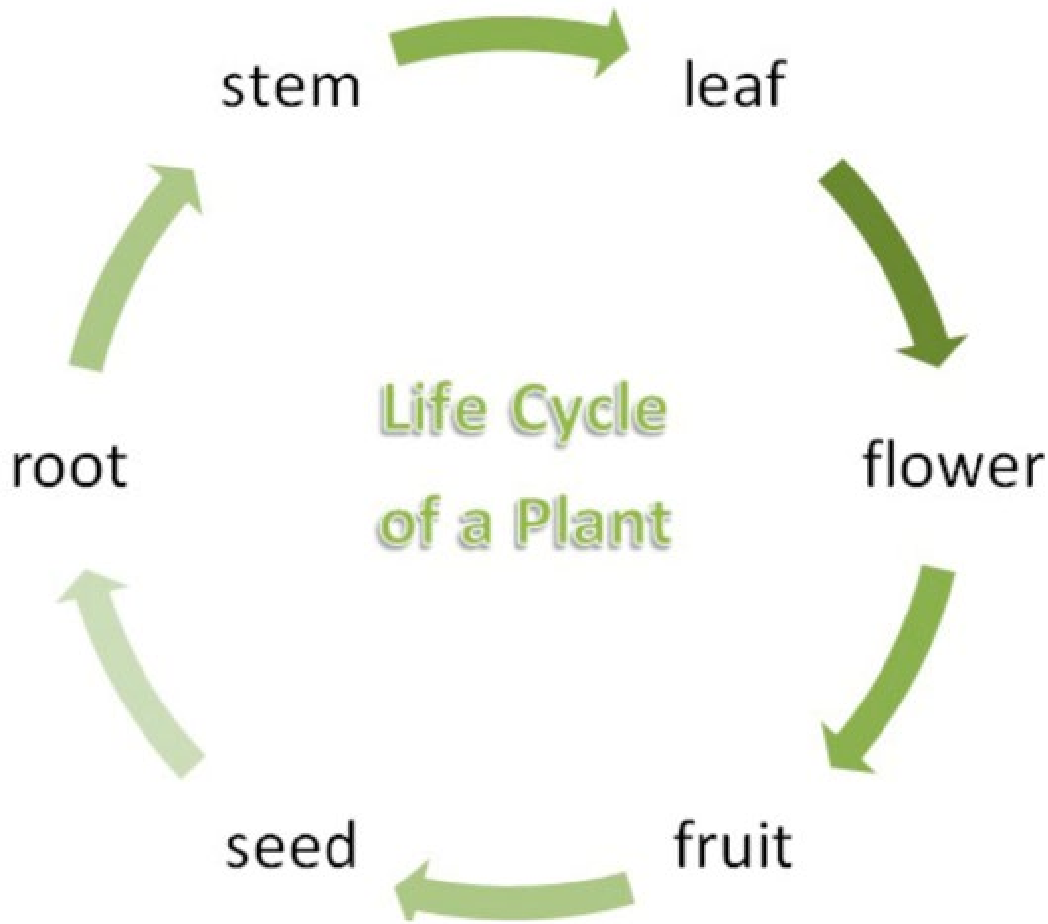
Draw and label the parts of a plant.

Seed Diary (Handout 2)

Parts of the Plant (Handout 3)



From Seed to Plant (Handout 4)



Read-to-Write Strategy PowerPoint Presentation

WRITING A SEQUENCE TEXT USING A MENTOR TEXT AS A GUIDE

1

2ND GRADE WRITING STANDARD:

2. Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

a. Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension.
b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic.
c. Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially).
d. Use precise language and domain-specific vocabulary to inform about or explain the topic.
e. Provide a concluding statement or section related to the information or explanation presented.

*In this lesson, we will use a mentor text to model for students how to write informational text.

2

Today, we will read a book to learn how an author writes about a sequence or life cycle. In this book, the author wrote about the sequence of how an egg becomes a chicken or the life cycle of a chicken. We will write this paper together. Next, you will be writing about the life cycle of a plant or how a plant grows.

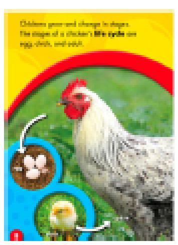
*You will also have another book to look through at the end of the lesson.

3

Step 1: Let's look at this book to see the title the author chose for this book. Look at the cover. What is this book going to be about? How can you tell? It looks like this book is going to tell us how an egg becomes a chicken. Do you see the pictures along the side of the cover – eggs, chick, chicken? What title did the author use? Step 1: Think about what is your title going to be for your paper about plants. What can the title of our paper about the life cycle of a chicken be?

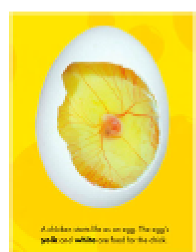
4

Step 2: Next you need to introduce your topic to the reader. The first couple of sentences is where the author lets the reader know what the book will be about. See how the author introduced this book… Step 2: Let's write an introduction so that the reader knows that the paper we write together will be about the life cycle of chickens.



5

Step 3: Next, the author begins to write about how an egg becomes a chicken. Step 3: In your paper, you will write about the steps of how the seed becomes a plant. What is the first step? In our paper about the chicken, what is the next step?



6

Step 4: Next, the authors keep writing about the steps of how the egg becomes a chicken. Step 4: In your paper, you will keep writing about the steps of how a seed grows to a plant. What can we add to our paper about the chicken?

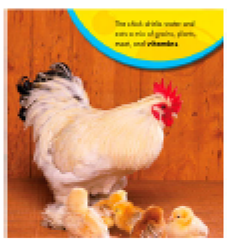
7

Step 5: If you have more information to share, keep writing! The more information you have, the better. Step 5: Next, keep adding information until you have shared all that you know about the life cycle of a plant. What else can we write about the life cycle of a chicken?

8

Step 6: When writing about the life cycle or sequence of events, we use signal words to help the reader understand. Here are some of the words authors use when writing about a sequence:

- from
- when
- first
- next
- before
- afterwards
- then
- finally
- following



Step 6 : What signal words could you use in your paper? We will use the same ones in our paper about chickens.

9

Step 7: Here is the last page. See how the author provides a conclusion? She writes about the grown up chicken. You could do the same with the life cycle of a plant. What does the final stage look like?

Step 7: What concluding sentence could you add to your paper? What concluding sentence should we add about chickens?

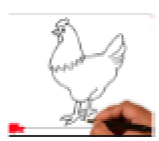
10

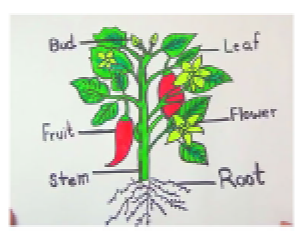
Step 8: Now let's read through our paper. Let's be sure to check spelling and punctuation. Does it make sense? Did we include signal words? Does it have a title?

Step 8: Read, review, and fix your paper.

11

Step 9: If you have time, draw a picture, diagram, or include a photo of the topic you are writing about. Step 9: Add pictures, drawings, diagrams, or other visuals.





12

Teacher: Distribute the books to students or pairs of students. Explain to students that they will be locating the title, introductory sentence, concluding sentence, signal words, and the parts where the author shares the sequence or life cycle of something.

How to Write a Sequence or Life Cycle Paper

Step 1: What is title of the book you have?

Step 2: Can you find the introduction the author used so that the reader knows what the paper will be about?

Step 3: What information did the author share about the life cycle of something? What is the first step of the process?

Step 4: What else does the author share about the sequence or life cycle?

Step 5: What other information can you find that the author shared about the life cycle?

Step 6: Can you find any signal words that the author used? (from, when, first, next, before, Afterwards, then, finally, following, before, after, next, then…)

Step 7: Did the author write a concluding sentence?

Step 8: Check the spelling and punctuation in this book. Did the author use correct spelling and punctuation?

Step 9: Can you find any pictures, drawings, diagrams, or other visuals the author used?

13

Now you are ready to write your paper about the life cycle of a plant. Follow the steps on the chart to help you.

How to Write a Sequence or Life Cycle Paper

Step 1: What is your title going to be?

Step 2: Write an introduction so that the reader knows what the paper will be about.

Step 3: Write about the life cycle of a plant. What is the first step of the process?

Step 4: Keep writing about the stages of the life cycle of a plant.

Step 5: Keep adding information until you have shared all that you know about how the life cycle of a plant.

Step 6: What signal words could you add to your paper?

Step 7: What concluding sentence could you add to your paper?

Step 8: Now read through your paper. Be sure to check capitals, spelling, and punctuation. Does it make sense?

Step 9: Add pictures, drawings, diagrams, or other visuals.

14

APPENDIX H

Data Spreadsheets

Holistic Rubric Scores

Number	Pre-instruction		Pre-instruction	Post-instruction		Post-instruction
	Purpose/Focus & Organization	Conventions/ Editing	TOTAL	Purpose/Focus & Organization	Conventions/ Editing	TOTAL
1	2	1	**3**	2	1	**3**
2	1	1	**2**	2	1	**3**
3	2	1	**3**	1	0	**1**
4	2	1	**3**	2	2	**4**
5	2	1	**3**	3	1	**4**
6	2	0	**2**	1	1	**2**
7	1	0	**1**	2	1	**3**
8	1	0	**1**	2	1	**3**
9	1	1	**2**	2	1	**3**
10	2	2	**4**	3	2	**5**
11	2	1	**3**	1	1	**2**
12	1	2	**3**	3	2	**5**
13	1	1	**2**	2	1	**3**
14	2	1	**3**	2	2	**4**
15	2	2	**4**	3	2	**5**
16	3	1	**4**	2	2	**4**
17	3	2	**5**	3	2	**5**
18	3	1	**4**	3	1	**4**
19	1	1	**2**	2	2	**4**
20	0	0	**0**	2	1	**3**
21	2	1	**3**	3	1	**4**
22	2	1	**3**	3	1	**4**
23	3	2	**5**	4	2	**6**
24	2	2	**4**	2	2	**4**
25	1	1	**2**	1	1	**2**
26	2	1	**3**	1	1	**2**
27	1	1	**2**	3	1	**4**
28	1	1	**2**	3	2	**5**
29	1	1	**2**	2	1	**3**
30	1	1	**2**	1	1	**2**
31	1	0	**1**	2	1	**3**
32	1	1	**2**	1	1	**2**
33	2	2	**4**	3	0	**3**
34	0	0	**0**	2	1	**3**
35	1	1	**2**	3	1	**4**
36	3	1	**4**	2	2	**4**
37	1	1	**2**	0	0	**0**
38	2	2	**4**	3	2	**5**
39	2	2	**4**	3	2	**5**
40	2	2	**4**	2	1	**3**
41	1	1	**2**	2	1	**3**
42	2	2	**4**	3	1	**4**
43	3	2	**5**	3	2	**5**
44	0	0	**0**	1	0	**1**
45	3	2	**5**	3	2	**5**
46	1	1	**2**	2	1	**3**
47	1	1	**2**	2	1	**3**
48	1	1	**2**	1	0	**1**
49	2	1	**3**	3	2	**5**
50	2	1	**3**	3	2	**5**

Number	Pre-instruction		Pre-instruction	Post-instruction		Post-instruction
	Purpose/Focus & Organization	Conventions/ Editing	TOTAL	Purpose/Focus & Organization	Conventions/ Editing	TOTAL
51	1	1	**2**	2	1	**3**
52	0	0	**0**	0	0	**0**
53	1	1	**2**	3	2	**5**
54	3	2	**5**	4	2	**6**
55	1	1	**2**	1	1	**2**
56	2	2	**4**	2	2	**4**
57	0	1	**1**	2	1	**3**
58	1	1	**2**	2	2	**4**
59	3	1	**4**	3	1	**4**
60	0	1	**1**	2	1	**3**
61	3	1	**4**	3	2	**5**
62	3	1	**4**	3	2	**5**
63	3	1	**4**	2	1	**3**
64	1	0	**1**	3	1	**4**
65	0	1	**1**	2	2	**4**
66	2	2	**4**	3	2	**5**
67	0	0	**0**	0	0	**0**
68	0	0	**0**	1	0	**1**
69	1	2	**3**	2	2	**4**
70	1	0	**1**	1	0	**1**
71	2	1	**3**	2	2	**4**

Analytic Rubric Scores

Number	Analytic Pre-Instruction									Pre
	Topic Intro	Steps of the Plant Life Cycle	Concluding Statement	Signal Words	Capitalization	Punctuation	Spelling	Word Count	TOTAL	Weighted
1	4	4	2	2	0	0	1	4	17	2.75
2	0	1	0	0	0	0	3	1	5	0.5
3	0	2	0	1	0	0	1	4	8	1.05
4	0	3	0	4	3	4	2	4	20	2.35
5	2	2	0	2	1	3	3	2	15	1.75
6	4	3	0	0	4	1	2	4	18	2.05
7	0	3	0	2	0	0	2	4	11	1.6
8	0	1	0	0	1	0	1	2	5	0.5
9	4	2	0	1	3	4	2	3	19	2
10	0	4	0	4	4	4	3	4	23	2.75
11	2	2	0	0	1	2	2	3	12	1.3
12	0	2	0	2	4	4	3	4	19	1.75
13	2	3	0	1	1	4	2	4	17	1.95
14	4	3	1	2	4	4	2	4	24	2.75
15	0	3	0	2	4	3	2	4	18	1.95
16	4	4	0	1	1	2	4	4	20	2.55
17	0	4	0	4	4	4	2	3	21	2.65
18	0	3	0	4	1	4	2	2	16	2.15
19	0	2	0	2	2	4	2	3	15	1.55
20	0	0	0	0	0	0	0	0	0	0
21	4	4	4	2	0	4	2	4	24	3.3
22	0	3	0	2	2	1	2	1	11	1.6
23	4	4	0	4	3	4	2	4	25	3.25
24	0	2	0	2	4	4	2	4	18	1.7
25	0	2	0	2	1	1	2	2	10	1.3
26	4	3	2	2	0	4	2	4	21	2.7
27	0	2	3	2	0	0	3	3	13	1.75
28	0	2	0	2	0	0	3	0	7	1.15
29	3	2	0	2	0	1	2	4	14	1.8
30	2	3	0	1	3	3	2	2	16	1.9
31	2	3	0	3	0	0	1	4	13	2.05
32	2	1	2	1	0	3	1	4	14	1.5
33	4	1	0	2	1	2	2	1	13	1.6
34	0	0	0	0	0	0	3	0	3	0.15
35	0	1	0	0	0	1	3	0	5	0.5
36	4	2	3	3	4	4	2	4	26	2.95
37	0	2	0	1	1	1	1	2	8	1.05
38	0	2	0	2	3	3	3	2	15	1.55
39	4	2	0	0	3	3	2	3	17	1.75
40	0	2	0	4	3	3	2	2	16	1.9
41	2	0	0	0	0	3	1	1	7	0.55
42	0	3	0	4	4	4	2	2	19	2.3
43	0	3	0	2	4	4	2	2	17	1.9
44	0	0	0	0	0	0	0	0	0	0
45	2	3	3	4	2	4	2	3	23	3
46	2	0	0	0	1	2	1	3	9	0.65
47	4	3	2	0	0	1	1	3	14	2.05
48	2	3	0	1	0	1	1	2	10	1.6
49	0	3	0	1	2	1	2	2	11	1.45
50	4	3	0	2	0	1	3	2	15	2.2

Number	Analytic Pre-Instruction									Pre
	Topic Intro	Steps of the Plant Life Cycle	Concluding Statement	Signal Words	Capitalization	Punctuation	Spelling	Word Count	TOTAL	Weighted
51	2	0	0	0	0	1	3	1	7	0.55
52	0	0	0	0	0	0	0	0	0	0
53	0	2	0	3	2	0	3	1	11	1.5
54	4	3	3	2	4	3	3	4	26	3.05
55	0	2	0	0	0	2	3	2	9	0.95
56	1	2	1	0	4	4	3	4	19	1.65
57	0	0	0	0	1	0	4	0	5	0.25
58	2	0	0	0	3	3	2	3	13	0.85
59	2	3	0	2	1	4	3	4	19	2.2
60	2	0	0	0	1	0	3	0	6	0.5
61	0	2	0	1	0	1	3	2	9	1.1
62	0	3	0	2	0	0	2	1	8	1.45
63	0	3	3	2	0	3	2	3	16	2.15
64	0	2	0	0	0	1	3	1	7	0.85
65	0	0	0	0	1	3	3	4	11	0.55
66	4	2	2	0	3	1	3	2	17	1.95
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	1	0	3	0	4	0.2
69	2	0	0	0	1	1	3	1	8	0.6
70	2	2	0	0	0	1	1	2	8	1.1
71	4	3	0	0	0	4	2	4	17	2

Number	Analytic Post-Instruction									Post
	Topic Intro	Steps of the Plant Life Cycle	Concluding Statement	Signal Words	Capitalization	Punctuation	Spelling	Word Count	TOTAL	Weighted
1	3	4	0	2	2	4	2	4	21	2.65
2	3	3	0	4	3	1	2	3	19	2.6
3	0	3	0	2	0	0	1	3	9	1.5
4	4	4	0	4	4	4	2	4	26	3.3
5	3	3	0	3	1	1	3	2	16	2.3
6	4	2	0	3	4	0	3	2	18	2.25
7	0	4	0	4	2	2	2	4	18	2.5
8	4	2	0	4	3	1	2	2	18	2.4
9	0	4	0	4	2	0	2	4	16	2.4
10	4	3	0	4	4	4	3	2	24	2.95
11	0	3	0	2	1	3	4	1	14	1.75
12	4	3	1	4	4	4	4	4	28	3.25
13	3	3	0	4	1	2	2	2	17	2.5
14	0	3	0	4	0	4	2	3	16	2.15
15	3	4	0	4	2	4	2	4	23	3.05
16	3	4	2	3	2	2	3	4	23	3.1
17	4	3	0	4	4	4	3	2	24	2.95
18	3	4	0	4	1	0	2	3	17	2.75
19	4	2	2	4	4	4	2	4	26	3
20	0	3	0	3	2	4	3	2	17	2.05
21	4	4	0	4	0	4	2	4	22	3.1
22	0	3	0	4	2	1	2	2	14	2.05
23	4	4	3	4	4	4	3	4	30	3.8
24	0	3	0	2	4	4	2	4	19	2
25	0	2	0	2	1	2	2	2	11	1.35
26	0	2	0	3	0	4	2	4	15	1.7
27	0	3	0	2	0	0	2	2	9	1.5
28	0	3	0	1	4	4	2	2	16	1.7
29	2	4	0	2	1	1	2	3	15	2.25
30	0	3	0	4	4	3	2	4	20	2.35
31	0	4	0	2	0	0	1	4	11	1.85
32	3	0	0	0	1	0	2	3	9	0.75
33	0	3	0	4	0	1	3	0	11	1.9
34	2	3	0	3	1	3	2	4	18	2.3
35	2	3	0	0	0	1	3	2	11	1.5
36	0	3	0	4	4	4	2	4	21	2.4
37	0	1	0	0	1	0	3	0	5	0.5
38	4	3	3	4	4	4	2	2	26	3.35
39	0	4	0	4	4	4	2	4	22	2.7
40	4	2	0	3	1	1	2	2	15	2.1
41	4	3	0	4	2	4	2	2	21	2.8
42	0	3	0	4	0	4	3	2	16	2.15
43	0	4	0	3	4	4	3	4	22	2.55
44	0	2	0	3	2	0	1	1	9	1.4
45	3	3	3	4	4	4	2	4	27	3.3
46	0	3	2	1	1	4	2	4	17	1.95
47	0	1	0	1	1	1	2	4	10	0.9
48	4	3	0	1	0	0	1	4	13	1.95
49	0	4	0	4	4	4	2	2	20	2.6
50	0	3	0	4	2	4	3	4	20	2.35

Number	Analytic Post-Instruction									Post
	Topic Intro	Steps of the Plant Life Cycle	Concluding Statement	Signal Words	Capitalization	Punctuation	Spelling	Word Count	TOTAL	Weighted
51	2	3	0	2	0	3	2	4	16	2.05
52	0	0	0	0	0	0	0	0	0	0
53	0	3	0	2	2	4	2	3	16	1.85
54	4	4	4	3	4	4	3	4	30	3.75
55	0	2	0	0	0	1	3	1	7	0.85
56	0	4	0	3	4	4	3	4	22	2.55
57	4	4	0	4	2	1	2	4	21	3.05
58	4	3	3	4	3	4	2	4	27	3.4
59	0	3	0	3	0	1	3	3	13	1.85
60	2	2	0	1	0	4	0	1	10	1.35
61	2	3	0	3	2	4	3	3	20	2.4
62	0	3	0	4	4	4	2	3	20	2.35
63	0	4	0	3	2	4	2	3	18	2.35
64	0	4	0	2	1	4	2	4	17	2.15
65	0	4	0	2	1	4	3	4	18	2.2
66	0	4	3	3	4	4	3	4	25	3
67	0	0	0	0	0	0	0	0	0	0
68	0	2	0	0	0	0	3	0	5	0.75
69	0	3	3	2	2	4	3	3	20	2.35
70	2	2	0	0	1	1	1	3	10	1.2
71	4	3	3	1	3	4	2	4	24	2.8