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Self-management of cognitive load in children: Exploring effective strategies by manipulating informational text

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SELF-MANAGEMENT OF COGNITIVE LOAD IN CHILDREN:

EXPLORING EFFECTIVE STRATEGIES BY

MANIPULATING INFORMATIONAL TEXT

An Abstract of a Thesis

Submitted

In Partial Fulfillment

Of the Requirements for the Degree

Master of Arts in Education

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ABSTRACT

This study was designed to measure which reading comprehension strategies were most successful in allowing children to self-manage their cognitive load while reading electronic informational text. It built on previous research on cognitive load theory and teaching children self-management strategies. Participants were sixth grade students in a Midwestern suburban intermediate school.

A quantitative experiment was conducted with a control group and three experimental groups. Experimental groups were taught to highlight key words, draw arrows to show process on a diagram, or move text boxes nearer a corresponding illustration. The control group received equal time with the teacher but did not receive training on strategy use. Participants rated their mental effort during the learning phase and testing phase. No statistically significant differences were found between the experimental and control groups on recall items, near-transfer items, and far-transfer items on the post-reading comprehension test. A small but not significant improvement was seen in participants who were taught to highlight key words.

Discussion and recommendations are included for how this study relates to existing literature on cognitive load theory and children's self-management of cognitive load. Recommendations include replication with a larger and more diverse sample size in hopes of achieving more significant results.

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Entitled: Self-Management of Cognitive Load in Children: Exploring Effective Strategies by Manipulating Informational Text

has been approved as meeting the thesis requirement for the

Degree of Master of Arts in Education

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CHAPTER 1

INTRODUCTION

Best practices in literacy education encourage teachers to select texts for students that provide enough challenge to facilitate growth and new learning but that are not so difficult as to frustrate a student. While this is a practical goal for a controlled classroom setting, today's students are accessing texts on various platforms that are not always formatted optimally for their comprehension. Students living in the digital age must be equipped with the knowledge of how to make text work for them. This study begins with an overview of effective ways to teach reading, and then provides an explanation of metacognition as a way for readers to make sense of text, how students can think about their own cognitive load during a reading task, and how these apply to reading of informational text, particularly in electronic form.

Summary of Previous Research

This work is situated within the larger debate over how to measure readers' proficiency, including how teachers can help readers become more efficient at comprehending text. It is particularly focused on examining self-management techniques that may make a complex informational text easier to understand. Argument over whether the text or the reader's thoughts should dominate (Goodman, 1970; Gough, 1972) has informed how theorists and practitioners alike seek to understand the reading process. Other researchers advocate that a combination of both is needed to make meaning during the process (Perfetti, 1985; Stanovich, 1980) Researchers such as

Pearson (2004) have argued that to truly understand reading, we must study it like a science.

One might say that proficient readers employ both their working memory and long term memory to make sense of words (Reichle, Pollatsek, Fisher, & Rayner, 1998) and that a reader's schema can be called to aid working memory in its processing of text, making the job less cognitively taxing (Paas & Sweller, 2012). If readers can use their knowledge of the reading process to make sense of text, could readers use similar knowledge to make a potentially challenging text easier to read and comprehend? Explicit instruction and practice of comprehension strategies have long been central components of quality reading instruction in the classroom. The ability to gauge one's understanding of a text (metacognition) is key to becoming a proficient reader (Hofer & Sinatra, 2009). Strategies such as rehearsing new information repeatedly are especially helpful in moving new information into long-term memory (Roberts et al., 2014). These strategies can reduce the burden on working memory and free up resources for information retention. Finding ways to efficiently move information into long-term memory is a major goal of Cognitive Load Theory (Sweller, 2010).

The major goal of this study is to add to the literature on effective strategies for self-managing cognitive load. Measuring their efficacy in use by children is a relatively new focus in cognitive load research. It is hoped that certain methods will prove well-suited for use by children and that, once learned, children are able to apply these methods independently in their reading of texts.

The Research Problem

How do typical students approach a text that is cognitively challenging for them to read and comprehend? Consider the following scenario: Andrea is a sixth grade student whose social studies class is investigating the building of Egypt's Great Pyramid. She uses her computer to examine a website explaining a theory of how Egyptian builders brought heavy blocks to the building site. Andrea refers to a graphic organizer provided by her teacher to guide her information-seeking process. Still, she finds it difficult to follow the website's organizational scheme. She re-reads text to improve her comprehension to no avail. Frustrated, she ends the class period with little to show for all her efforts. If Andrea had received training in how to self-manage her cognitive load during informational text reading tasks, the outcome of her efforts may have been different. Perhaps she would have been able to recognize that the website she was using caused her a large degree of extraneous cognitive load that impaired her comprehension. Noting this, she may have employed one or more strategies: highlighting or drawing arrows near important information in the text, or manipulating the text itself by moving diagrams closer to accompanying text so her eyes did not travel unnecessarily around the page attempting to connect the necessary information. Also, Andrea may have benefitted from training in use of tools available on her computer or by copying and pasting the website's text into an appropriate word processing program.

Sweller (2010) attempted to measure the amount of cognitive load people experienced when performing complex tasks, such as during the act of reading. This research identified ways instructional designers could make potentially challenging or complex materials easier for readers to comprehend--for example, by placing diagrams and related text close together. From a psychological standpoint, instructional materials can only be retained for later recall if they are first processed in a reader's working memory. If a reader's limited cognitive resources are taxed by trying to make sense of a challenging text, fewer resources are available for meaning-making processes (Perfetti, 1985). A major goal of cognitive load theory research is to determine how instructional materials can be optimally formatted to increase the likelihood that what a person reads is processed, acquired within schemata, and placed in long-term memory for later use. The term *schemata* in this study will be used to describe the brain's way of organizing related information for use in cognition (Harris & Hodges, 1995).

This study is inspired by the only known study involving child participants asked to self-manage their cognitive load during reading. In that study (Gordon, Tindall-Ford, Agostinho, & Paas, 2015), participants performed better on a post-reading assessment if their materials contained related information close together. Participants whose information was less optimally formatted performed worse on the post-test. This confirmed the hypothesis that requiring readers to split their attention negatively affected comprehension. However, a second hypothesis was not confirmed. It was that participants who had been trained to self-manage their cognitive load by highlighting, drawing arrows, or moving text boxes would comprehend better than the control group with no self-management training. It is possible that the act of manipulating the text during self-management introduced additional cognitive load that impaired comprehension compared to other participants. Gordon et al.'s (2015) recommendations for future research included attempting to isolate the self-management strategies of highlighting, drawing arrows, or moving text boxes. The current study will try to isolate what participants are doing (highlighting, drawing arrows, or moving text boxes) to see if certain self-management strategies have more positive or negative effects on comprehension than others. This addresses a gap in existing literature. It extends a previous study thought to be the first of its kind to examine children's efforts at self-managing their cognitive load. It was conducted in an authentic school setting. Most previous research in self-management of cognitive load was conducted with college-age participants.

An explanation of what successful readers do when reading is provided in the following chapter. Then, an overview of existing literature in the fields of reading comprehension and metacognition, cognitive load theory, informational text reading, and electronic reading is provided. Each of these areas overlaps in the current study to provide a context in which to view what young readers do when presented with a cognitively challenging text, and which self-management strategies merit more focus in today's classrooms. Findings will be applicable to anyone with a responsibility for, or interest in, helping children navigate an increasingly complex world of electronic informational text, and how children can best be taught to make sense of those texts on their own.

CHAPTER 2

LITERATURE REVIEW

What do good readers do? And how do we define good readers and what good reading truly is? Learning to read is a complex cognitive act (Eklund, Torppa, & Lyytinen, 2013; Furnes & Norman, 2015; Miciak et al., 2014) with a history full of controversy and disagreement over the nature of reading and the best ways in which to teach beginning reading. This study will examine what early adolescent readers do when confronted with an unfamiliar informational text. This question will be explored in terms of readers' ability to manipulate or change more challenging components of a text, by use of electronic drawing tools or moving text. The following literature review provides a brief history of effective ways to teach reading, considering the cognitive demands of the reading process and how readers' form mental representations of a text. Next, use of metacognition as a way for readers to make sense of text and to organize their thinking around a text is outlined. In the section on cognitive load, background information on theoretical understandings of cognitive load in reading tasks are discussed. Finally, several studies encompassing informational text, electronic reading devices, and their effect on comprehension, are presented.

Mental Models: Schema, Comprehension, and Recall

Goodman (1970) described the act of reading as a psycholinguistic guessing game, one in which a reader combines semantic, syntactic, and graphophonic cues to make meaning. For proponents of this top-down, or whole language approach, the focus of early reading instruction is on creating meaning, not identifying words rapidly and accurately. Yet other theorists proposed just the opposite. In Gough's (1972) bottom-up approach to reading, emphasis was placed on decoding larger units of meaning--letters, words, phrases, and sentences. He thought a reader's ability to comprehend was the result of combining larger units of meaning, and he placed primary emphasis on teaching early readers to identify words rather than comprehend what they were reading. This disagreement over the most effective way to teach reading became known as The Reading Wars, and it is still fueling debate in the reading research community today.

Pearson (2004) stated "Reading research can never be truly rigorous, indeed truly scientific, until and unless it privileges all the empirical and theoretical methodologies that characterize scientific disciplines" (p. 15). Scientific methodology is important to ensure the most efficacious approaches to teaching early reading. More recent research on models of reading has shown that efficient readers combine several types of knowledge--lexical, as well as specific content knowledge and more general knowledge--along with comprehension in order to make meaning from printed text (Perfetti, 1985). Stanovich (1980) proposes an interactive-compensatory model of reading in which a reader uses a combination of higher-level and lower-level mental processes to construct meaning from text, and points out that careful consideration about the cognitive demands of a reading task must be given relative to the strengths and weaknesses of the reader.

Paas and Sweller (2012) explain that "schemas can be brought from long-term to working memory to govern activity" (p. 28). Humans can combine many separate elements of knowledge into one schema, making the information less cognitively taxing to use.

Van den Broek and Espin (2012) explain that “the coherence of a reader’s mental representation of a text [indicates] his or her comprehension” (p. 316). Similarly, Reichle et al. (1998) suggest that young readers engage higher-order processes such as working memory in tandem with long-term memory to make sense of words, and that they do so as early as fifth grade. This means even very young readers experience reading processes similarly to adults. The difference is that young readers are not as proficient in these processes as adults. Working memory must have sufficient resources available to make sense of what is being read and conduct important information into long-term memory. This is particularly interesting when we consider how young readers might use their knowledge of the reading process to make sense of texts that are formatted in ways that make them more difficult to read and comprehend.

My interest is in how readers activate their schemata from previous reading tasks and apply that knowledge in new, and perhaps more complex, reading tasks. Also, it is worth examining whether young readers can appropriately identify the complexity of a given text and manipulate that text through electronic means. In particular, use of highlighting, drawing arrows, and moving text and diagrams nearer each other will be considered as techniques for making complex informational texts easier to comprehend.

Reading Comprehension Strategies

The major purpose of reading is to comprehend the written material. Reading comprehension is consistently referred to as an essential component of classroom literacy instruction (Calhoon, 2005; Duke & Block, 2012; Gut et al., 2004) Readers use comprehension strategies to help them make sense of text, and to recognize and fix when meaning breaks down. The use of metacognition is a strategy that readers can employ to check whether they are comprehending as they are reading. The term *metacognition* is defined as thinking about one's own thinking, or awareness and regulation of cognition (Hofer & Sinatra, 2009). The act of being metacognitive requires an awareness of one's self as a reader in terms of relevant strengths and weaknesses. Practicing the use of effective reading comprehension strategies is critical in young readers' development. Readers are able to use strategies when they have enough cognitive capacity to do so. The studies outlined in this section speak to the importance of teaching students how to use reading comprehension strategies and how to self-monitor that use.

Bråten and Anmarkrud (2011) extended a previous study in which they had observed four Norwegian high school classrooms for the amount of reading comprehension strategy instruction. One hundred and four ninth-grade students and their teachers were observed for a three-week period. Student participants were divided into two groups based on their teachers' type of reading comprehension instruction. The type of instruction was either surface level or deeper level. Participants were asked to read an expository social studies text on a topic with which most participants had little prior knowledge. Bråten and Anmarkrud measured participants' knowledge of the topic, their use of comprehension strategies during reading, and their reading comprehension performance after reading. Participants whose teachers had provided time for students to practice using their reading strategies at deeper levels of application indeed used higher level strategies and had better reading comprehension compared to peers whose teachers had given them only surface-level strategy instruction. However, the participants with the deeper strategy instruction did not necessarily use higher-level strategies with any greater frequency than their peers who had not been exposed to deeper strategy use.

One way of teaching students to be metacognitive about their use of reading comprehension strategies is the use of a standardized program. Several studies have focused on the effects of specialized training programs that require teachers to follow a prescribed method of teaching students to read and comprehend text. The typical goal of such programs is to develop readers' automatic use of strategies. Carretti, Caldarola, Tencati, and Cornoldi (2014) found that teachers who implemented specific training programs designed to increase students' working memory and text comprehension could increase student achievement on standardized assessments. The largest gains were in use of metacognitive knowledge. Three groups were formed from 159 students aged nine to 11. One group was trained in reading comprehension only, a second group trained in listening comprehension only, and a control group that received no specific training. Results showed both reading and listening training were effective at improving reading achievement from pre- to post-tests, but students trained in reading comprehension did best overall. Also, these students showed improvement in listening comprehension on the post-test, whereas students in the listening comprehension group only improved on the listening portion of the post-test.

Some programs of this type have focused particularly on students' self-awareness of what they do while reading. Mason, Meaden-Kaplansky, Hedin, and Taft (2013) taught 58 low-achieving students to use Self-Regulated Strategy Development Instruction (SRSD). Participants were taught to use the SRSD strategies before reading, while reading, and after reading. This approach included explicit modeling from teachers in how to set goals, monitor reading behavior, and use positive self-talk. They received approximately 15 thirty-minute sessions over a two-month period in use of SRSD. Participants were interviewed at the conclusion of the lessons to determine levels of awareness about how they applied the self-regulation strategies while reading. Fifty-six of 58 participants reported feeling their use of SRSD made them better readers. However, they required substantial teacher support to establish goals and engage in self-talk about what to do while reading. Participants' goals were so similar within classrooms that it appeared teachers heavily influenced their students' goal creation. While it was unclear whether participants were ready to use self-regulation strategies continuously, most participants self-reported three main outcomes from their training: wanting to show teachers their work, wanting to read more difficult texts, and feeling they were now better readers.

Other such studies taught students a routine for reading and thinking designed to increase awareness of how they read. McCown and Thomason (2014) evaluated fifth grade students' use of metacognitive and cognitive strategies when reading informational text using the Collaborative Strategic Reading (CSR) model. This model teaches students four techniques to engage in while reading: Preview (brainstorming and predicting), Clink and Clunk (vocabulary), Get the Gist (writing), and Wrap Up (summarizing and questioning). A quasi-experimental design used the Qualitative Reading Inventory-5 (QRI-5) and the Georgia Criterion-Referenced Competency Test (CRCT). Results were that the experimental group significantly outperformed the control group on the QRI-5 but found no difference on the CRCT. The authors state this was the first study on CSR's effect on metacognition, and future studies should examine metacognitive awareness, self-regulation, and self-efficacy of students reading informational text.

Each of these studies show metacognition can be effective in helping students monitor their understanding of what they read. Additionally, metacognition as a reading comprehension strategy takes another form as a way for students to promote important information into their long-term memory. Roberts et al. (2014) studied the effectiveness of a method called Promoting Acceleration of Comprehension and Content through Text (PACT), as used by middle school participants in a history course. Participants engaged in metacognitive elaborative rehearsal, or continuously thinking about and talking about a lesson's content, as a way to facilitate deeper processing. It was hypothesized that this emphasis on rehearsing and discussing at the moment initial learning occurred would lighten the load on mental processing. This may allow for better recall later, even if little schema existed for the new information. Results suggested that participants who had engaged in the metacognitive rehearsal had more success with recalling key lesson content information later than participants who had not been coached in the strategy.

A third component to how metacognition is used in the classroom is as a tool for regulation among discussion partners in a group setting. These collaborative assignments are ones requiring students to generate ideas, share their thinking with others, and integrate peers' thinking with their own. Molenaar, Sleegers, and van Boxtel (2014) studied participants' use of metacognition in during group work. Four types of intra-group social metacognitive interaction were studied: ignored, accepted, co-constructed (participants create a single idea together), and shared (participants accept others' unique ideas). Fifty-four students were sorted into 18 heterogeneous triads, with teachers ranking and sorting students as low, middle, or high ability readers. The researchers randomly assigned each triad to one of three experimental conditions: structuring scaffold, which directly supported the group's work; problematizing scaffold, which provided questions to prompt participants' metacognitive processes; and a control group, which saw the same computer interface as the experimental groups but received no scaffolding support. When participants' conversations were transcribed and coded, both of the experimental groups had exhibited more interactions than the control group. The group that received the problematized scaffolding (such as question prompts) engaged in more socially constructed thinking and was less likely to ignore each other's' metacognition. It was suggested that the problematized scaffolding prompted the individual group members to do their own thinking first, which led to greater conversation within the group.

Kohsa and Volet (2014) followed 11 undergraduate students in a Veterinary Medicine course as they worked in one of two groups to plan their own learning objectives and analyze an animal case study. The studies chosen were ones with which participants were likely to have little prior knowledge. The authors had the participants create concept maps in order to see their thinking, and those maps were then compared to expert maps drawn by outside veterinarians who had studied the same cases. A videotape of each group's work was analyzed and coded. No significant differences were found between the two groups in terms of metacognitive regulation (e.g. planning, monitoring, and evaluating their work). A notable difference was in the amount of time the two groups spent engaged in higher level thought processes. Group A may have been attempting to meet only the basic requirements of the task. This may be the reason they spent so much time in low-level thinking. Group B may have seen the task as a way to grow in their medical knowledge. The researchers also noted one instance of social metacognition, defined as self-regulation, co-regulation of others, and awareness of others' misconceptions. In this case, a participant realized her own misconception of anorexia, as well as identified the misconceptions held by her other group members during their conversation.

Such results speak to the importance of readers' self-awareness about their level of understanding when reading a text, and the benefit of combining their schema with text in order to make meaning. These studies appear to affirm the value of teaching students particular reading comprehension strategies such as metacognition. They also point to the importance of providing opportunities for students to engage in critical thinking and reflection on their reading experience. This level of participants' own self-awareness of their reading behaviors is important to the current study. Self-awareness of when to use a reading comprehension strategy is especially important in terms of participants' mental effort exerted during a reading task. This will be discussed further in the next section on cognitive load.

Cognitive Load

Cognitive load is the amount of mental effort required for a certain task. The idea of cognitive load was advanced in the form of Cognitive Load Theory (CLT) by John Sweller and others (e.g. Kalyuga, 2011; Paas & Ayres, 2014; Paas & Sweller, 2012; van Marrienboër & Sweller, 2005). It originated from the Verbal Efficiency Theory by Perfetti (1985). These researchers were interested in how instruction could be designed to reduce extraneous cognitive load for learners. Extraneous load can be modified by the instructor, such as how he or she chooses to convey a given piece of information. A major goal of CLT is to ensure information is being conveyed in the most efficient way possible--one that does not unnecessarily burden the recipient's working memory capacity. Also, other types of cognitive load, such as germane (helpful to processing and constructing schemata) and intrinsic (a part of instruction that cannot be changed, such as a lesson's content), have been included. The idea is that if instruction can be designed to place little strain on working memory, the ability to learn, retain, and recall information will be maximized by allowing it to make its way to long-term memory, and subsequently integrated into existing schemata. It has since grown to include the study of reading comprehension using texts in various modes and is applicable to many contexts including education, such as will be discussed in the ensuing sections.

Two major ways of understanding how readers use available attention to assist in deriving meaning from the reading process came in the form of Verbal Efficiency Theory

(Perfetti, 1980) and the Selective Attention Strategy (Reynolds, 1992; Reynolds, Wade, Trathen, & Lapan, 1989). Both provided a foundation on which researchers developed further theories about the mental effort required to perform certain tasks. Perfetti stated that meaning and comprehension of a text was possible at a high level only if a reader was able to rapidly and accurately decode words. This would conserve available attention for use with higher order strategies. If not, the reader’s task would be so laborious and slow that meaning and comprehension would suffer. In the context of CLT, this means that if a reader’s working memory is taxed, the reader’s ability to comprehend the text or to perform nearly any other task will be lessened, sometimes significantly. Similarly, the Selective Attention Strategy (Reynolds et al., 1989) stated that readers learn important information better than less important information because they devote more attention to information they perceive as important. To do so, of course, readers must be able to both identify important information and focus more attention on that information in order to learn it effectively (Reynolds, 1992). Feldmann-Wüstefeld, Uengoer, and Schubö (2015) found that attention allocation for these predictions was affected by prior learning experiences. People learn to pay more attention to stimuli that has led to successful outcomes in the past. They pay less attention to stimuli that has not led to desired outcomes. Readers with an impaired ability to quickly shift their attention from one stimulus to another can experience processing deficits that would likely lead comprehension to suffer (Krause, 2015). The effects of selective attention have been observed in other contexts, such as marketing, where people used to selecting a certain product are more likely to continue selecting that product when it is offered as a choice among competing products (Janiszewski, Kuo, & Tavassoli, 2012).

Again, in the context of CLT, an efficient reader is one who has sufficient cognitive resources devoted to deriving meaning from the text. Cognitive Load Theory suggests that adults responsible for structuring the learning environment must ensure that tasks are planned in such a way as to minimize distractions that might unnecessarily strain cognitive resources. Several recent studies have examined whether tasks with distractions--such as requiring a reader to search across a page of text for an accompanying diagram--negatively affect a reader's ability to select, store, and recall key information. Furthermore, these studies sought out whether readers could be taught to self-manage these distractions in ways that permitted them to read and comprehend more effectively.

Roodenrys, Agostinho, Roodenrys, and Chandler (2012) undertook three studies on cognitive load that explored whether materials that required participants to split their attention, such as when a diagram and related text are separated on a page, could be managed by participants on their own. This is termed a split-attention effect in CLT. In one study, participants who were given time and support to practice how to self-manage for split attention without engaging in any reading were most successful compared to peers when they were later asked to engage in reading unfamiliar material. Success was measured on a reading comprehension post-test. Results pointed to the fact that students could indeed be taught to self-manage their cognitive load with a positive effect on their reading comprehension. Roodenrys et al. (2012) found that many participants inaccurately attributed their use of a self-management strategy to their improved reading comprehension, indicating that some students are unable to link their actions while reading to their comprehension after reading. This may be due to a lower level of self-awareness. Major implications from this research include teaching students to self-manage cognitive load before requiring them to perform any learning tasks, teaching the use of arrows, numbering, and highlighting to aid learning, and that students are capable of applying learned self-management behaviors in new contexts.

Similar interest in teaching students to self-manage cognitive load is seen in two studies by Agostinho, Tindall-Ford, and Roodenrys (2011). They reported preliminary findings from one study on how to teach students to self-manage cognitive load using computer based tools. Participants used Interactive Whiteboards and SMART Notebooks to modify text by drawing on, moving, or highlighting it. Three groups were randomly formed and provided with differing materials: (1) received materials requiring split-attention (e.g. text and diagram located far apart) that could not be modified; (2) same as Group 1 but able to be modified (e.g. moved or highlighted); (3) control group whose materials were not formatted as split-attention and could not be moved. Each group studied their materials for three minutes and completed a post-test on reading comprehension. The authors anticipated that participants who were taught how to self-manage split attention (Group 2) would perform better than the control (Group 3). Findings were that it was possible to teach students to self-manage cognitive load.

In a related second study, Agostinho, Tindall-Ford, and Roodenrys (2013) investigated whether teaching students to move a text box closer to a diagram was an effective method for students to self-manage cognitive load when reading online text that presents a split-attention effect. Three groups were formed: one in which the participants could not move the text and diagram, and they were not close together; a second group where participants could not move the text and diagram but they were presented close together on the page; and a third group where participants could freely move the text box. Results showed participants who had to move the textbox reported exerting more mental effort than peers who did not move text, but it did not affect their ability to recall what they had read. Participants who could move the text performed better on recall than participants whose diagram and text were separated. Participants whose text and diagram were placed close together but could not be moved also performed better than those peers with split materials. These results show that readers benefit from low demands on their limited cognitive resources--not having to search a page of text and illustrations to mentally bring needed information together.

Most recently, Gordon et al. (2015) tested whether Year 5 and 6 students in Australia were able to self-manage a split-attention effect while reading science materials. Students were randomly assigned to one of three conditions: (1) split-attention materials (text and diagram separated); (2) integrated materials (text and diagram close together); and (3) self-managed (text and diagram had to be moved together, then participants must draw arrows between corresponding boxes and highlight key words). The experiment unfolded in four phases: training, identifying prior knowledge of the science content, learning, and testing. Also, participants were introduced to a mental effort rating scale to be completed during the learning and testing phases. Completion of the testing phase tasks confirmed the presence of the split-attention effect. Participants in the integrated condition significantly outperformed the split-attention on total recall tasks and far-transfer tasks. However, the self-managed condition did not outperform the split-attention condition, which differed from the researchers' hypothesis. Neither did the self-managed condition perform any differently from the integrated condition. It may be that self-management tasks added extraneous cognitive load that took away resources for comprehension.

Cognitive load has also been explored in other industries such as health care. In one sub-study as part of a larger randomized trial on health education, Danilenko (2010) provided participants one of three pictorial scaffolds for metacognition, concept, or procedure while performing a comprehension task. Most participants self-reported both the cognitive load of the task and their impression of their own effort as low. This suggests that scaffolding should only be provided when text is complex or confusing in its design, as no significant differences in comprehension were seen among the three groups.

The previous studies on the whole seem to indicate a promising new area of cognitive load research--whether participants can be taught to self-manage their own cognitive load when presented with reading materials that are less than optimally formatted in terms of text and diagram placement (split attention effect). When text and diagrams are placed apart as in a split-attention effect, readers must devote more cognitive resources to integrating that information, thus permitting them fewer resources to devote to other processes, such as comprehension.

Previous research in CLT has shown that when textual and pictorial information are located in close proximity, participants think they exert less mental effort in reading and comprehending the information. Some studies have shown promise in teaching participants to manipulate their own cognitive load during a reading task by highlighting, drawing arrows, moving boxes, or otherwise modifying the text in such a way that makes the information easier for the participant to comprehend, process, and store. In the modern world information can be easily manipulated by highlighting, drawing, or otherwise marking and modifying text. It is worth studying how that may affect a reader's behavior when reading a text on an electronic device. In the next section, several studies exploring readers' use of electronic text will be discussed.

Reading Electronic Text

Today's prevalence of electronic devices has led to increased research literature on how readers use electronic text and how they interact with electronic text when reading. Several such studies have combined the study of electronic text reading with its effect on readers' cognitive load. Results from these studies indicate that most readers are able to construct mental representations of an electronic text similarly to what is done when reading printed text (Margolin, Driscoll, Toland, & Little Kegler, 2013). Mental processes and demands, in terms of cognitive load, do not appear any greater in electronic text compared to printed text, although novel demands such as highlighting using an electronic tool may have a slight negative impact on comprehension (Lan, Lo, & Hsu, 2014). Other studies bear out the finding that electronic text is no more cognitively demanding than printed text and may actually hold a small comprehension benefit for certain subgroups of readers (Schneps, Thomson, Chen, Sonnert, & Pomplun, 2013). Success in reading electronic text may have more to do with degree of skill a reader brings to the reading process than the format of the text (Coiro & Dobler, 2007).

One such study measuring how readers use electronic text was completed by Margolin et al. (2013). They studied 90 participants who were divided randomly into three reading groups, each using a different text format: hard copy, computer, or e-reading device. The participants read five literary passages and five expository passages controlled for length and reading level. They answered comprehension questions. Results indicated no significant differences in comprehension among the groups, suggesting that the format in which a text is presented does not affect readers' comprehension. The researchers noted whether reading behaviors such as tracking with a finger or a mouse, highlighting text, or moving lips were observed from the participants. For participants reading on the computer, there was a significant correlation between overall comprehension if they followed along with finger or mouse or moved their lips while reading. The act of highlighting text accounted for significant variance in comprehension accuracy of the narrative passages. Also, Kindle readers were significantly less likely to skip around while reading compared to participants reading on paper. This study showed that readers were "able to create and update their situational model representations of the text without significant interference from the media platform" (p. 517).

Though studies such as the one conducted by Margolin et al. (2013) found text format did not affect comprehension, other researchers have sought to measure the impact of text format on readers in different ways. Brünken, Plass, and Leutner (2003) conducted a meta-analysis of research studies that attempted to measure cognitive load of readers and its effect in electronic text reading in particular. The main finding was that text format did not affect comprehension. In a follow-up study, Brünken, Plass, and Leutner (2004) extended previous work with cognitive load and electronic text, this time using a within-subjects experimental design to study how participants responded to a presentation containing both audio and visual modes versus visual only. In a second experiment, they introduced background music to determine if it increased cognitive load. Results from the first study indicated cognitive load was higher when two modes were required. In the second study, listening to background music had no effect on cognitive load.

Recent work regarding the use of electronic reading devices, or eReaders, has shown promise for readers who struggle, such as those with dyslexia. Schneps, Thomson, Sonnert et al. (2013) used eye-tracking measures for high school students with dyslexia. They found that when the eReader was used to manipulate the text by making shorter lines of text appear on the screen, reading speed increased while saccades and fixations decreased, without any adverse effect on comprehension. Short lines allowed readers to guide attention toward less visually crowded areas.

Subsequent work by Schneps, Thomson, Chen et al. (2013) compared how high school readers with dyslexia read on paper as opposed to how they read on an eReader. Similar to the earlier study by Schneps, Thomson, Sonnert et al. (2013), e-reading improved speed and comprehension, most notably for the subgroup of participants who struggled with phoneme decoding and sight word automaticity. That subgroup gained the most in speed, and participants with limited visual acuity spans gained better comprehension with the eReader.

Lan et al. (2014) conducted a meta-analysis of 17 studies about metacognition, reading comprehension, and electronic text. They found the majority (51%) included undergraduate students, with secondary students and elementary students being the second and third most often used participants respectively. Most interventions were only provided one time, with total time ranging from as little as 20 minutes to as much as 125 minutes. Results, while mixed, tended to show that little to no differences existed in the level of reading comprehension between participants who read hard copy text and those who read electronic texts. Indeed, some studies appeared to indicate that using electronic tools, such as highlighters or dictionaries, could cause additional work for students that detracted from their metacognition and subsequent comprehension. However, the authors found little evidence of exactly what components of electronic text influence readers' comprehension--and in particular, poor readers' use of metacognitive strategies--when reading electronic text.

Research by Coiro and Dobler (2007) explored what good readers do when reading online text. The researchers examined the reading behaviors of 11 sixth grade readers who were deemed good readers because of their high grades on report cards and standardized test scores, along with previous experience finding and reading texts on the Internet. Coiro and Dobler posited that Internet-based texts with clickable links present many choices for readers. Good readers must be able to self-regulate their reading to search for and locate the texts that best match their purpose for reading. Through observations and interviews after the searching and reading tasks, the authors noticed participants repeating searches to gather information they may have missed the first time, and engaging in effective reading behaviors such as reading the introduction for key ideas, and skimming and scanning as a pre-reading activity. Participants read text while actively determining how well it met their information-seeking needs. Their reading behaviors differed somewhat from behaviors seen when reading printed text, as participants needed to possess prior knowledge of how Internet search engines worked in addition to prior knowledge about their reading topic. They were required to make more predictive-type inferences during reading. The authors highlighted the importance of this behavior for Internet-based text, as incorrect inferences could confound a reader by leading him or her on a seemingly endless search across the Internet, whereas incorrect inferences about printed text do not hold this danger. Thus, Corio and Dobler state, electronic reading is complex because readers must be mindful of both their text and its content, while readers of printed text need only to worry mostly about the content itself.

Just as important as how readers use informational text is how often and in what ways their teachers afford students opportunities for information text reading in the classroom. Ness (2011) surveyed 318 teachers of grades Kindergarten through fifth across six U.S. states. Ness queried these teachers in three areas: (1) how often they used informational text in instruction; (2) how many informational texts were available to students in the classroom; and (3) teachers' personal attitudes toward informational texts. Ness found that teachers were mostly positive about including informational texts in the classroom. They reported devoting slightly more than 30 minutes daily of classroom time to informational texts and about 32% of classroom library space to them. Noteworthy findings were that second grade teachers reported more informational texts in their classroom libraries than their Kindergarten and first grade teaching peers. This spike leveled out across third and fourth grade teachers' libraries. Fifth grade teachers actually reported fewer informational texts in their classroom libraries even though they felt they were spending more class time on teaching with informational texts. The most common obstacles teachers reported were lack of resources, students' lack of knowledge about a topic that prevented them from reading independently, and competing demands on classroom time for other curricular areas.

Findings such as these might suggest a need for further research on how readers interact with text to employ particular reading strategies such as metacognition and self-awareness of their understanding of the text (McCown & Thomason, 2014; Molenaar et al., 2014). More comparisons between reader behavior with paper-based text and electronic-based text would add to current understanding of what components of a text are most important to readers' comprehension (e.g. Lan et al., 2014; Margolin et al., 2013). In particular, more research is needed on how cognitive load factors in to students' understanding of text and whether students can be taught to manage their own cognitive load (Brünken et al., 2003, 2004; Roodenrys et al., 2012). Another area of exploration is to make comparison among different types of electronic texts based on their level of learning and modality.

The current study will attempt to address a gap in the existing literature by measuring younger students' cognitive load of a reading comprehension task, as most extant research has used undergraduate participants. Gordon et al. (2015) conducted the only known research on self-management of cognitive load by children. This study will assess how participants respond after being taught strategies for self-managing cognitive load by manipulating electronic informational text. Methods with which participants already have some experience, such as highlighting and drawing tools, will be used. Only a small number of these studies focus on how participants are self-managing their cognitive load. Even fewer studies have explored participants' self-management of cognitive load while reading in the genre of electronic text specifically, specifically among participants who are children.

A potential problem with the current study is the lack of a commonly accepted method of measuring participants' degree of cognitive load. A typical method (e.g. Agostinho et al., 2013) is to employ a self-rating scale for effort, which is subjective in nature. This study will follow the study by Gordon et al. (2015) in use of a version of a mental effort self-rating scale originally developed by Paas.

CHAPTER 3

METHODOLOGY

This study will make use of a convenience sample of students from the researcher's own sixth grade class roster. It seeks to build from a study by Gordon et al. (2015). The researcher will seek to isolate the three self-management techniques in that study (highlighting, drawing arrows, and moving text boxes) in hopes of determining which techniques introduce undesirable extraneous load and which promote germane load that aids participants' learning.

Research Question

Do certain self-management techniques (highlighting, drawing arrows, moving text boxes) introduce extraneous load that negatively impacts participants' learning?

A more specific aspect of this question is do participants trained to move text boxes as a method for reducing cognitive load experience increased learning compared to peers who use techniques of highlighting or drawing arrows?

Hypotheses

Hypothesis 1

Participants who use the self-management strategy of moving text boxes nearer to corresponding text (thus reducing the split-attention effect) will experience less cognitive load during reading than peers who use self-management techniques of highlighting or drawing arrows.

Hypothesis 2

Highlighting and drawing arrows will cause an extraneous load that will have a negative effect on participants' learning as measured by a post-test compared to peers who moved text boxes.

Participants

This study included a convenience sample of 27 students from the researcher's classroom roster. Participants were part of this researcher's sixth grade combined literacy and social studies classes that met every school day for approximately 90 minutes. Each participant was randomly assigned to one of four conditions:

- Split attention: Materials contained text and diagrams separated (split-attention effect) and could not be moved by the participant. The participant was unable to use any tools to modify the text, including highlighting, drawing arrows, or moving text boxes.
- Split attention with highlighting: Materials contained text and diagrams separated (split-attention effect) and could not be moved by the participant. The participant was able to use a highlighting tool on the text.
- Split attention with drawing arrows: Materials contained text and diagrams separated (split-attention effect) and could not be moved by the participant. The participant was able to use a tool to draw arrows on the text.
- Split attention with moving text boxes: Materials contained text and diagrams separated (split-attention effect) and participant was able to move text

boxes as desired. Participants were not able to use tools such as highlighting or drawing arrows.

Procedure

Materials on the water cycle were presented to each participant. The text and accompanying diagram were identical for each group except where differences were necessary as part of the experimental conditions. Materials were presented in an electronic format as a Google Document because each participant had a Google Apps for Education account provided by the school, its use was a normal part of their classroom routine, and reading texts in electronic form was familiar for participants. Each participant used his or her school-issued computer to complete the experimental task.

Training Phase

Each participant used his/her school-provided computer and it can be assumed all participants were familiar with the basics of operating their computer and accessing and reading text in electronic form, as this was a normal part of their classroom routine. Participants were trained on how to use tools appropriate to their condition, such as using the text highlighting tool, the drawing tool to draw or insert arrows, or how to use a mouse/touchpad to move text boxes nearby corresponding text. Training was provided by the researcher in small groups to facilitate a more intimate training environment. This also allowed the researcher to provide assistance to participants who needed extra modeling before using their tool(s) independently. All participants were in condition-alike groups to avoid contamination of treatment. The researcher used a script to ensure consistency in directions given among all groups, and all groups received approximately the same length of training.

Identifying Prior Knowledge Phase

Participants had two minutes to record everything they could recall about the topic (the water cycle) being presented in their materials, without seeing the actual materials. They recorded their prior knowledge using paper and pencil.

Learning Phase

Participants were presented with their materials and had seven minutes to study them. All instructional materials were presented in electronic format as Google Documents via the Google Classroom learning management system. Materials were identical except for necessary differences among conditions. At the conclusion of the learning phase, participants rated their own mental effort using the provided mental effort rating scale. This was the same scale participants would use after the test phase. Participants had previously rated themselves on this scale after completing a word puzzle that was unrelated to the topic of this experiment in order to provide practice thinking metacognitively about their mental effort.

Test Phase

Participants were asked to work through six questions. The researcher read a script and used a timer to ensure consistency among all conditions. Participants were instructed not to share the nature of any part of their instructional materials with other participants so as to avoid diffusion of treatment.

Post-reading questions were identical for each condition. Responses were collected on paper, but participants were given a code so as to not be identified by name. Each response was also scored by a second teacher familiar with the topic of the instructional materials to effect inter-rater reliability. A short description of questions and their purpose is:

1a. Literal recall; participants labeled terms on a diagram.

1b. Near-transfer task; participants explained relationships between processes in their own words.

2, 3, and 4. Near-transfer task; participants explained key concepts in their own words.

5 and 6. Far-transfer task; participants applied their understanding of processes to novel contexts.

At the end of this phase, participants completed the same mental effort rating scale they had used at the end of the learning phase.

Scoring Procedure

After the primary researcher (the author) reviewed each participants' post-reading test and instructional materials for compliance appropriate to condition (e.g. drawing arrows the correct direction, highlighting key words), a second scorer reviewed a random sampling (N=7; 25.9%) of post-reading tests. The second scorer confirmed the primary researcher's scorings on each test sampled (7/7; 100%).

Materials

A repeated measures ANOVA was used to determine if any of the experimental groups (highlighting, drawing arrows, or moving text boxes) achieved better scores on the post-reading comprehension test compared to other experimental groups or the control group. Questions were grouped into domain-alike categories for this analysis as follows: recall domain (Q1a-Q1b), near-transfer domain (Q2-Q4), and far-transfer domain (Q5-Q6). For purposes of this study, a recall question was one where participants were asked to remember previously learned facts. A near-transfer question required participants to apply previously learned information to a scenario about the water cycle. A far-transfer question asked participants to apply previously learned information to a scenario that was similar to but not exactly like the water cycle (e.g. explaining how boiling water in a pot with a lid demonstrates a cycle). Questions were based on those in the original study by Gordon et al. (2015). Also, participants self-reported mental effort during the learning phase and the testing phase. This self-reporting was analyzed using one-way ANOVA.

CHAPTER 4

RESULTS

The design was a 4 (group) x 3 (question type) repeated measures design; hence, a repeated measures ANOVA was used to analyze the data. The group factor had four levels (control, highlighting, moving text boxes, and drawing arrows). The question type factor had three levels (recall, near-transfer, and far-transfer). A significance threshold of .05 was set. The analysis yielded no significant results (all $p > .05$). Table 1 shows the within cell means and standard deviations.

Table 1

Means and Standard Deviations for Post-Test Scores

Condition	Recall	Near-transfer	Far-transfer
Control (N=7)	M=2.14 SD=1.51	M=1.76 SD=1.34	M=1.57 SD=1.09
Highlighting (N=8)	M=2.75 SD=3.02	M=2.00 SD=1.56	M=2.69 SD=1.35
Text boxes (N=6)	M=3.00 SD=2.30	M=1.83 SD=1.38	M=2.58 SD=1.00
Arrows (N=6)	M=1.58 SD=1.08	M=1.83 SD=1.76	M=2.08 SD=1.88

Table 2 shows the effect size for each post-test question. Cohen's *d* (1977) was used to calculate effect sizes. A result where *d* = .2 or less was considered a small effect size; *d* = .3 to .7 was considered a medium effect size; and *d* = .8 or greater was considered a large effect size. All of the effect sizes in this study were considered small.

Table 2

Effect Sizes for Post-Test Scores

Question	Cohen's *d*
1a	.09
1b	.07
2	.01
3	.09
4	.01
5	.24
6	.09

Results of a repeated measures Analysis of Variance (ANOVA) showed no significant differences between the control group and the experimental groups on the post-reading comprehension test. Neither did it show any differences among any of the experimental groups. No group performed significantly better than another; thus, it cannot be determined with certainty if any of the self-management strategies aided or detracted from comprehension. It may be hypothesized that participants who were required to implement a strategy experienced an increase in extraneous cognitive load while performing the strategy, and this caused them to perform no better than the control group that used no strategy.

CHAPTER 5

DISCUSSION

Conducting research with child participants about their self-management of cognitive load is an emerging area. Cognitive load was defined as the amount of mental effort a participant was required to use when reading (Paas & Sweller, 2012). Three reading comprehension strategies that had potential to aid reading comprehension—highlighting key words, drawing arrows to show process in a diagram, and moving text boxes nearer a corresponding illustration—were introduced to participants in a sixth grade classroom.

The current study built upon Gordon et al.'s (2015) recommendation for future research by attempting to isolate the three strategies. This was done in an attempt to determine which of the three strategies, if any, best allowed participants to comprehend what they read.

Research Question

The research question for the current study asked whether certain self-management techniques (specifically, highlighting key words, drawing arrows to show a process, or moving text boxes nearer a diagram) would introduce extraneous cognitive load that negatively impacts learning. Learning was measured in terms of post-reading comprehension questions. Further, this study sought to determine whether participants who were trained to move text boxes experienced increased learning compared to peers who used techniques of highlighting or drawing arrows.

Hypothesis 1

Hypothesis 1 was that participants using the self-management strategy of moving text boxes nearer corresponding text (thus reducing the split-attention effect) would experience less cognitive load during reading than peers who used self-management techniques of highlighting or drawing arrows.

This hypothesis was not confirmed in the post-reading comprehension question results. Participants in the control group answered comprehension questions with similar degrees of accuracy as participants in any of the experimental groups. It may be that strategy use did not increase germane load enough to positively affect comprehension.

Hypothesis 2

Hypothesis 2 was that highlighting and drawing arrows would cause an extraneous load that would have a negative effect on participants' learning as measured by a post-test compared to peers who moved text boxes.

This hypothesis was not confirmed in the post-reading comprehension question results. Although participants who highlighted key words scored slightly better than any other group, their scores were not statistically significant enough to attribute any increased comprehension to use of the highlighting strategy.

Thus, the null hypothesis could not be rejected in this experiment. These findings were inconsistent with previous research that found participants had better comprehension when they were able to move text boxes closer to a diagram than when the two remained separated (Agostinho et al., 2013). In the current study, participants who could move text boxes in this way comprehended similarly to all other participants.

One possible explanation for neither of the two hypotheses being confirmed is that participants were unfamiliar with the high degree of structure and procedure necessary for conducting an experiment. This may have caused enough extraneous cognitive load in the classroom environment to negatively affect reading comprehension. Similarly, it may be that asking participants to use a strategy introduced enough extraneous load that they could comprehend the text no better than peers who had not been asked to use any strategy.

Another consideration is that participants only received one training session on how to use their strategy. It may have been that participants, who were children, required more training with their strategy in order to use it independently.

It must also be noted that the sample size for this study was small (N=27). It is often difficult to find meaningful effect sizes with so few participants, an issue which will be addressed in the following section on implications and future recommendations.

Implications and Future Recommendations

For Researchers

The field of cognitive load theory and its related research continues to grow, but research in this area involving child participants is fairly new and relatively sparse. Replication of this study with a larger sample size would be useful, particularly with the potential to enlarge the effect sizes in order to draw more accurate conclusions about which, if any, of the experimental conditions boost comprehension. Also, large-scale research across more diverse demographics or multiple school sites may prove beneficial to the existing body of research on teaching children to self-manage cognitive load. It is hoped that by adding more participants, results of greater statistical significance may be found. Any such findings will add to the existing literature concerning which, if any, self-management strategies are most effective for children to self-manage cognitive load when reading.

Hattie (2009) conducted a broad review of meta-analyses to identify the most effective teaching practices in terms of their effect sizes. He found the teacher was one of the most influential factors on student learning. Students were more likely to learn when they had clear goals and the teacher provided effective feedback to move them toward those goals (Hattie, 2012). Student outcomes were highest when students saw themselves as active participants in the learning process with a teacher capable of providing the right support at the right moment (Terhart, 2011).

For Teachers

Results of this study may indicate that children who are asked to focus on other tasks while reading (e.g. highlighting, moving text boxes, or drawing arrows) may experience no better comprehension than peers who are asked to use no such strategy. This is not to say that such strategies are unnecessary. For example, highlighting key words in a text as was done by some participants in the current study has previously been found to have significant effect on comprehension (Margolin et al., 2013). Under the right conditions, and especially when students are pre-taught appropriate techniques for highlighting, it can be beneficial to their retention of a text (Yue, Storm, Kornell, & Bjork, 2015). Also, this is congruent with findings on selective attention (Reynolds,

1992) because the reader must place more cognitive resources in identifying important information when highlighting. Larson (2012) found participants were more likely to use strategies such as highlighting when using an e-reader because markings could more easily be erased compared to a paper text. Participants also found e-readers useful for taking notes, defining unknown words, and other tasks participants thought aided their comprehension.

A teacher's instruction of such strategies to children could still be beneficial, providing them with multiple engagements, and gradually working children up to independent application. Though the majority of today's students are familiar with technology, they still need a teacher to guide them in how to make sense of electronic text (Larson, 2007). It may be helpful for teachers to intentionally select which strategies to introduce based on knowledge of students' prior achievement and knowledge of a particular strategies' efficacy in a specific learning context. Prior research has shown teachers evaluate the usefulness of a particular instructional strategy based on personal preference and past experience rather than any evidence-based measure (Carter, Stephenson, & Hopper, 2015).

Other relevant studies have shown placing more emphasis on instruction with electronic texts may prove helpful to students. Ness (2011) found classroom teachers spent on 30 minutes per day instructing students how to read and interpret features of informational text. Reading paper text compared to electronic text may not always mean substantial changes in cognitive load demands (Margolin et al., 2013). Mothibi (2015) found a significant positive relationship between students' use of e-learning tools and academic achievement measures. Most students have favorable views of e-reading technology after using it and make little distinction between paper-based or screen-based reading (Larson, 2007).

Children's ability to self-manage their cognitive load when reading is an area worthy of further attention. Previous studies have proven children can be taught to self-manage cognitive load. More research is needed to identify the best strategies for children to employ when reading, as is more research to identify the instructional methods that best help children learn to use such strategies independently and with efficacy.

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APPENDIX A

MENTAL EFFORT SELF-RATING SCALE

Directions: Put an X in the box that represents how much mental effort you used during this task.

1 very, very low mental effort	2 very low mental effort	3 low mental effort	4 slightly low mental effort	5 neither low nor high mental effort	6 slightly high mental effort	7 high mental effort	8 very high mental effort	9 very, very high mental effort

APPENDIX B

PARENTAL CONSENT FORM

Parent Permission Form for Student Participation

Spring 2016
Dear Parent or Guardian:
As part of my graduate studies in Literacy Education at the University of Northern Iowa, I am conducting a study on how children read text online. Your child has been invited to participate in a research project conducted through the University of Northern Iowa. The University requires that you give your signed agreement to allow your child to participate in this project. The following information is provided to help you made an informed decision whether or not to participate.

This study will be conducted as part of our regular classroom routine and will not interfere with your child's normal education. The study consists of reading informational text on the water cycle. Students will interact with the text by highlighting, drawing arrows, or moving text boxes. They will also answer some simple questions about the text and rate how much mental effort they exerted while reading. The project will be explained in terms that your child can understand, and your child will participate only if he or she is willing to do so. Only my UNI professors and I will have access to information from your child. Students will be given a code to use and will never use their real names. At the conclusion of the study, pseudonyms will be used to report results. No names will be used.

Participation in this study is voluntary. Your decision whether or not to allow your child to participate will not affect the services normally provided to your child by the PSEUDONYM Community School District. Your child's participation in this study will not lead to the loss of any benefits to which he or she is otherwise entitled. Even if you give your permission for your child to participate, your child is free to refuse to participate. If your child agrees to participate, he or she is free to end participation at any time. You and your child are not waiving any legal claims, rights, or remedies because of your child's participation in this research study.

If your child does not participate, he/she will still experience the same activity as students who are participating (as it is a normal part of our classroom routine) but his/her data will not be analyzed or reported.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of using numbers instead of names to record student answers. In the final results, pseudonyms will be used.

Should you have any questions or desire further information, please call me or email me at XXXXXX or (XXX) XXX-XXXX. You may also contact my faculty advisor for the project, Dr. Ralph Reynolds at ralph.reynolds@uni.edu or (319) 273-6910.

Keep this letter after tearing off and completing the bottom portion and having your child **return it to TEACHER A** (this is to maintain student privacy so I will not know who is/who is not participating). If you have any questions about your student's rights as a research subject, you may contact the University of Northern Iowa Office of Research and Sponsored Programs at (319) 273-3217 or rsp@uni.edu.

_____YES, I hereby agree to allow my son/daughter to participate in this project on how children read online text. I am fully aware of the nature and extent of my child's participation in this project as stated above and the possible risks arising from it. I have received a copy of this form.

_____NO, I do not grant permission for my child to participate in this project on how children read online text.

______________________________	______________________________
Signature of Parent/Guardian	Printed Parent/Guardian Name
______________________________	______________________________
Printed Name of Child	Date

APPENDIX C

CHILD ASSENT FORM

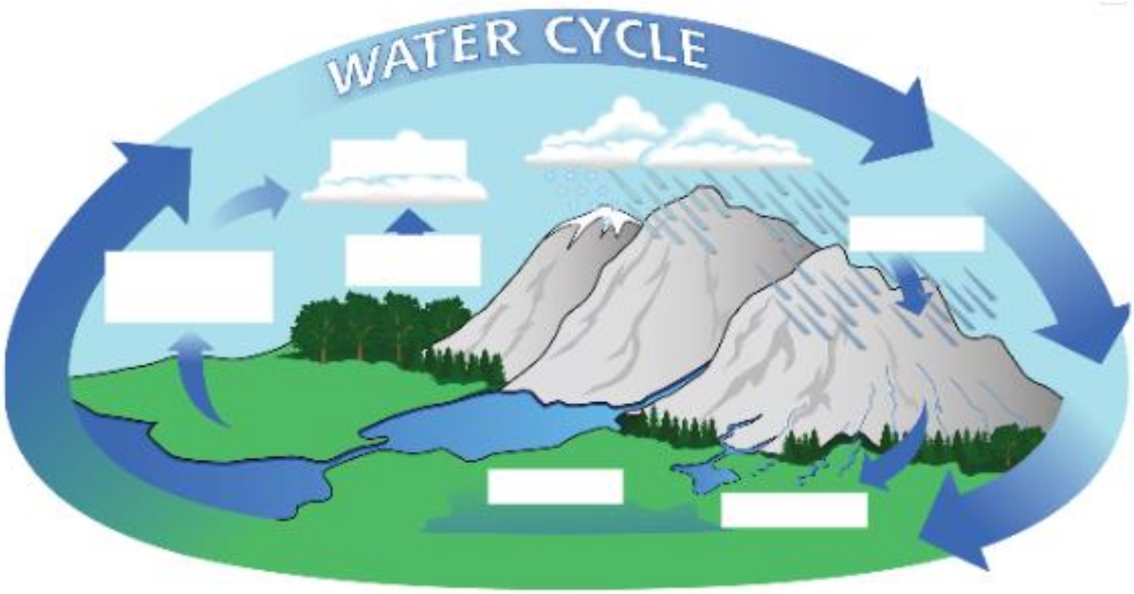
Student Assent Form
Title: How Children Read Text Online
Name of Principal Investigator(s): Marcus Hora

I, ______________________(my name), have been told that one of my parents/guardians has given his/her permission for me to participate in a project about how children read online text. I understand that my participation is voluntary. I have been told that I can stop participating in this project at any time. If I choose to stop or decide that I don't want to participate in this project at all, nothing bad will happen to me. My grade/treatment will not be affected in any way.

__________________________ ____________
Name Date

APPENDIX D

SAMPLE OF WATER CYCLE TEXT



Evaporation occurs when moisture from oceans, lakes, and streams is heated by the Sun and changes from liquid to gas.	Condensation is when moisture from the ground rises into the air and forms clouds.	Precipitation is when moisture falls from clouds. Types of precipitation include rain or snow.	Surface Runoff is precipitation that flows into streams, rivers, and eventually oceans.	Infiltration is precipitation that soaks into the soil. Some of it returns to the surface. What doesn't return stays underground and is called groundwater.	Transpiration is when water from the ground is pulled into a plant's roots and evaporates from the plant's leaves into the air.