The Pennsylvania State University

The Graduate School

THE EFFECTS OF STRUCTURE STRATEGY INSTRUCTION ON READING COMPREHENSION AND SELF-EFFICACY: MEDIATION AND MODERATION ANALYSIS

A Thesis in

Educational Psychology

by

Hui Zhao

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Master of Science

May 2020

The thesis of Hui Zhao was reviewed and approved* by the following:

Pui-Wa Lei
Professor of Educational Psychology
Thesis Advisor

Bonnie J. F. Meyer
Professor of Educational Psychology

David L. Lee
Professor of Special Education
Head, Department of Educational Psychology, Counseling and Special Education

ABSTRACT

Text structure strategy can help readers identify the organization of expository texts, encode information strategically, construct elaborated mental representation and boost reading comprehension. Consistent evidence has been shown that learners across age and language could benefit from structure strategy instructions on researcher-designed and standardized reading outcomes (Hebert, Bohaty, Nelson, & Brown, 2016); however, few studies assessed the instructional impacts on motivational outcomes such as self-efficacy, and the few that included reading comprehension and self-efficacy outcomes did not explore how or for whom structure strategy instruction was effective (Meyer et al., 2002; Wijekumar et al., 2014).

Self-efficacy, one's appraisal of capability in performing designated skills, can influence cognitive functioning, effort, persistence, affection, and selection of activities (Bandura, 1989). As such, self-efficacy is an essential educational outcome in and of itself. Moreover, self-efficacy has been found to be predictive of reading outcomes (e.g., Anmarkrud & Bråten, 2009; Solheim, 2011), and they might influence each other in a reciprocal manner (e.g., Hornstra, Van Der Veen, Peetsma, & Volman, 2013; Shell, Colvin, & Bruning, 1995; Sitzmann & Yeo, 2013). However, previous research on their directional influences or reciprocal relationships yielded mixed results (e.g., Andreassen & Bråten, 2010; Bråten, Ferguson, Anmarkrud, & Strømsø, 2013; Guthrie, Wigfield, Metsala, & Cox, 1999; Guthrie et al., 2007), likely due to domain mismatch of self-efficacy measures to reading and/or use of cross-sectional designs that could not provide strong evidence for directional relations.

This study intends to extend previous studies to provide more nuanced understandings of the effect of structure strategy instruction on reading comprehension and self-efficacy by addressing the how (mediation) and for whom (moderation) questions. First, we examined the effect of a web-based Intelligent Tutoring program for the Structure Strategy (ITSS) on self-

efficacy as well as how and to what extent this effect is mediated or moderated by reading comprehension. Second, we explored the effect of ITSS on reading comprehension, with an emphasis on the extent ITSS impact is mediated or moderated by self-efficacy. By analyzing secondary data from a large-scale cluster randomized control trial (RCT) of ITSS with pretest and posttest design, results from this study are also expected to shed light on the directional effects of reading comprehension and self-efficacy.

The analysis sample for this study consisted of 131 fourth-grade and 128 fifth-grade classrooms in the Northeastern U.S. In the original RCT, classrooms were randomly assigned to ITSS intervention or business-as-usual groups within schools by grade level. Students completed standardized reading tests and survey questions about structure strategy self-efficacy, reading self-efficacy, and learning self-efficacy before and after the intervention. Results from structural equation modeling suggested no significant treatment effect of ITSS instruction on self-efficacy regardless of grade. However, ITSS appeared to improve fifth-grade students' structure strategy and reading self-efficacy indirectly through its effect on reading comprehension performance. Furthermore, prior reading comprehension moderated the treatment effect on reading self-efficacy. Specifically, students with lower prior reading skills gained more on reading self-efficacy from the instruction. Implications and limitations are discussed accordingly.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my adviser Dr. Pui-Wa Lei for her invaluable guidance and suggestions throughout my writing of the master's thesis. I would also thank Dr. Bonnie J. F. Meyer for guiding me to write the literature review and helping me understand the text structure strategy.

This study is supported by a grant from the Institute of Education Sciences, Department of Education (Award No. R305A080133), U. S. The opinions reflected in this study do not represent the position of the Institute of Educational Sciences, Department of Education.

Chapter 1

Introduction

Reading is a basic skill in contemporary society as it lays the foundation for an individual's academic success in school as well as career pursuit throughout life (Anderson, Hiebert, Scott, & Wilkinson, 1985). However, reports of the National Assessment of Educational Progress (2017) indicated that U.S school children are facing great challenges in reading. Approximately 32% of students in fourth grade and 24% in eighth grade scored below the basic level, suggesting that many students are lacking the ability to extract the most important ideas from the text, integrate the contextual information with prior knowledge, make judgments on the opinions expressed by text author, and solve problems based on what they read (NAEP, 2017).

Reading research is concerned with a variety of reading outcomes, which includes decoding or phonological awareness (e.g., Anthony & Francis, 2005), word recognition (e.g., Adam, 2004), reading fluency (e.g., Menon & Hiebert, 2011), and reading comprehension (e.g., Duke & Carlisle, 2011; Frankel, Pearson, & Nair, 2011). Among these reading skills, particular importance has been attached to comprehension as it is often viewed as the "gold standard in defining prima facie of reading difficulties" (Frankel et al., 2011, p. 219).

Reading comprehension refers to the process of forming a coherent mental representation of the text by integrating the contextual information with the reader's prior knowledge (Kendeou, Van Den Broek, Helder, & Karlsson, 2014). To construct such representation requires the lower-level reading skills (e.g., decoding, reading fluency, vocabulary) and the higher-level reading skills (e.g., inference making, knowledge of structure, and cognitive control functions) (Kendeou et al., 2014). Difficulty in reading comprehension therefore could be attributed to diverse causes,

such as lacking the automatization of basic reading skills, having difficulty in identifying connections among text units, incapable of allocating sufficient attention to key information of the text, and failing to connect textual information with one's prior knowledge.

Meanwhile, research about self-regulated learning states that students are more likely to succeed in academic activities when they are motivated and self-regulated (Zimmerman, 1990). Zimmerman (1990) posited that an individual's lack of proficiency in reading may be due to motivational and affective causes, such as amotivation, anxiety, and unwillingness to regulate their behaviors. In general, low achievement in reading comprehension could be caused by limited knowledge and skills in reading, or negative motivational effects that impede the reader's engagement with the text, or both (Wigfield, Gladstone, & Turci, 2016). Thus, there is a need to examine the interrelationships among reading strategies, motivation, and reading achievement.

1.1 Statement of Problems

Varieties of reading strategies have been developed and adopted to target different types of problems in reading comprehension, among which the text structure strategy has been repeatedly shown to effectively promote reading comprehension through extensive research randomized research studies (Meyer & Poon, 2001). The text structure strategy can help struggling readers to taxonomize the structure of the text, figure out the logical connections among ideas in the text, summarize main ideas based on the text structure, and ultimately form a coherent representation of the text (Meyer, Brandt, & Bluth, 1980).

Text structure refers to how the idea units within an expository text are connected and integrated to express an opinion to readers (Meyer & Rice, 1984). The idea units may not be presented in a parallel form, but hierarchically instead because some of the idea units are more important than others in a text (Meyer & Rice, 1982). Meyer (1985) identified five text structures

that represent ways of thinking about topics. They are compare/contrast, problem/solution, cause/effect, sequence, and description. Compare/contrast is used to relate ideas by differences or similarities, problem/solution involves problems and responding solutions, cause/effect connects ideas with causal relations, sequence groups ideas chronologically, and description connects ideas by elaborating attributes and details (Meyer, 1985). Using the five rhetorical relations as the top-level structure, readers are able to taxonomize expository texts they encountered and produce a similar pattern of recall with the same structure but different content, which can free up readers' working memory and focus their attention on comprehension monitoring (Meyer & Ray, 2011).

Extensive studies have provided evidence that instruction of the text structure strategy provides an effective way to improve reading comprehension, in terms of researcher-designed measures and standardized reading tests, for participants across ages (e.g., Bartlett, 1978; Taylor, 1982; Armbruster, Anderson & Ostertag, 1987; Meyer & Poon, 2001; William et al., 2009; William et al., 2014), languages (e.g., Carrell, 1985; Davis, Lange, & Samuels, 1988; Raymond, 1993; Yeh, Schwartz, & Baule, 2011) and contexts (e.g., Meyer et al., 2002; Meyer et al., 2010; Wijekumar, Meyer, & Lei, 2012, 2017; Wijekumar et al., 2014, 2017). However, the instructional impacts on non-cognitive outcomes (e.g., motivation, affect) were insufficiently explored.

Motivation has been found to correlate with academic achievement, as it can initiate and sustain learning behaviors through goals, self-related beliefs and values (Linnenbrink-Garcia & Patall, 2016; Wigfield et al., 2016). Bandura's social cognitive theory (1989) proposed that humans do not respond to the environment mechanically but are capable of exerting controls over environmental events that affect their lives. And one of the most important mechanisms through which human can exercise their controls over the external world is self-efficacy beliefs (Bandura, 1989).

Self-efficacy beliefs refer to people's judgments of their capacities of initiating and executing actions to attain specific goals (Bandura, 1986). Academic self-efficacy (e.g., reading

self-efficacy, math self-efficacy) has been consistently shown to positively correlate with academic achievement across domains and grades (Honicke & Broadbent, 2016). Self-efficacy plays an essential role in the learning process, because it can impact an individual's choice of learning activities, how much effort he puts forth, and how long he persists while encountering difficulties (Bandura, 1977). Therefore, it is believed that children with high self-efficacy in reading would be more likely to sustain their commitment to the goals and hold persistent effort under stressful conditions, which may lead to better performance in reading comprehension. Nevertheless, self-efficacy alone cannot produce desired outcomes if the required skill is lacking and often there is an incongruence between one's self-efficacy beliefs and actual competence (Bandura, 1977).

The positive relationship between self-efficacy and reading comprehension has been supported by multiple studies; however, only a few studies examined the reciprocal or bidirectional relationship between them using the analysis of longitudinal data (Shell, Colvin, & Bruning, 1995). That is how self-efficacy influences the development of reading comprehension controlling for prior self-efficacy, and how reading comprehension influences the development of self-efficacy controlling for prior reading performance. Moreover, scarce are the number of studies that have focused on the reciprocal relationship within the context of structure strategy intervention. The interrelationships among structure strategy instruction, self-efficacy, and reading comprehension need to be further studied.

Previous research indicated that structure strategy instruction delivered through the web-based intelligent tutoring system (ITSS) had significant effects on fifth-grade students' reading and structure strategy self-efficacies. Meanwhile their prior self-efficacy in learning and reading were found to predict performances in reading comprehension (Wijekumar et al., 2014). This finding suggested that there could be an indirect effect of ITSS instruction on reading comprehension through self-efficacy beliefs, although the mediating effect was not tested in the

Wijekumar et al. (2014) study. Also, studies suggested that the treatment effect of structure strategy instruction on reading comprehension may be moderated by instructional design, reader's characteristics, and testing materials (Meyer, Wijekumar, & Lin, 2011); however, none of the studies has examined the moderating effect of self-efficacy. As self-efficacy was found to be predictive of reading comprehension, it is worthwhile to look into whether and how self-efficacy comes into play concerning the instructional impact on reading comprehension.

In addition, Bandura (1977) stated that achievement performance is the most powerful source of self-efficacy beliefs, and it is through mastery experience of success or failure that an individual begins to build and modify their perceived competence in a specific domain or task. Consistent with the theory, empirical evidence has been shown that prior reading skills can be predictive of subsequent self-efficacy beliefs (Hornstra et al., 2013). Unrau et al. (2018) found that, even though initial reading performance did not moderate the efficacy of reading intervention on reading self-efficacy, struggling readers showed more growth in reading self-efficacy when the treatment-control design was used. Currently, none of the previous studies has examined the mediating or moderating effect of reading performance on the relationship between structure strategy instruction and self-efficacy beliefs.

The purpose of this study is to extend the understandings of the effects of structure strategy instruction on reading comprehension and self-efficacy beliefs, by probing into the how (mediation) and for whom (moderation) problems. The study used secondary data collected by the ITSS research group (Wijekumar et al., 2012; Wijekumar et al., 2014). ITSS is a web-based program designed to offer structure strategy instructions via an intelligent tutor, provide practice exercises and instant feedback for learners in elementary and secondary schools (Wijekumar, Meyer, & Lei, 2013). Self-efficacy beliefs were measured in terms of structure strategy self-efficacy, reading self-efficacy and learning self-efficacy.

Research questions proposed to address the purpose of our study are:

1) Does reading comprehension mediate the effect of ITSS instruction on self-efficacy in structure strategy, reading, and learning?
2) Does prior reading comprehension moderate the effect of ITSS instruction on self-efficacy in structure strategy, reading, and learning?
3) Does self-efficacy in structure strategy, reading, and learning mediate the effect of ITSS instruction on reading comprehension?
4) Does prior self-efficacy in structure strategy, reading, and learning moderate the effect of ITSS instruction on reading comprehension?

Structural equation modeling (SEM) was applied to test the mediating and moderating effects posited in the study. Moreover, as Bandura (1997, 2001) suggested that using a task-specific measure of self-efficacy would be more predictive of academic achievement, this study also intends to address the problem of whether and how the specificity level of self-efficacy measure influences the mediation and moderation effects.

1.2 Significance of the Study

This study is expected to add to the current literature on the effect of structure strategy instruction on reading comprehension and self-efficacy beliefs by exploring the how and for whom questions. Specifically, the author explores the mediating and moderating effects of reading comprehension on the relationship between ITSS instruction and self-efficacy beliefs, and the mediating and moderating effects of self-efficacy on the relationship between ITSS and reading comprehension. This investigation may further our understandings of the interrelationships among structure strategy instruction, self-efficacy beliefs and reading comprehension for later grades students in the elementary school. Results of the mediation and moderation analyses are expected to have implications for the instructional design of ITSS. Also,

this study has the potential to further understanding in the reciprocal relationship between reading comprehension and self-efficacy in the context of elementary school classrooms. Compared with studies using the cross-sectional design, this study maximizes the advantages of the pre- and post-test longitudinal design and provides more rigorous evidence for the causal relations (Cole & Maxwell, 2003).

Chapter 2

Literature Review

The purpose of this study is to examine the relationship among the structure strategy instruction, reading comprehension and self-efficacy. This chapter provides a review of the current literature and is composed of three sections. The first section discusses the theoretical rationale and empirical evidence for the structure strategy instruction as well as its impacts on reading comprehension. The second section explicates the concept of self-efficacy, a keystone of the social cognitive theory, and reviews its connections with reading comprehension. Each section ends up with a statement of a research gap in that particular area. In the last section, research questions and hypotheses are provided.

2.1 Text Structure Strategy and Reading Comprehension

2.1.1 Text Structure Strategy

Text structure refers to the structural characteristics of text which is studied at three levels: micro-structure, macro-structure and top-level (Kintsch & van Dijk, 1978; Meyer & Freedle, 1984). Micro-structure is concerned with connections among units of information within or between sentences, whereas macro-structure focuses on the topic or gist of a paragraph as well as the organization among paragraphs (Meyer & Freedle, 1984). Top-level structure refers to the overall organization of the text, and by using the top-level structure readers are expected to encode information and retrieve it from their memory systematically and efficiently (Meyer,

Brandt, & Bluth, 1980). This study is focused on the strategic knowledge of top-level structure because it helps readers find out logical connections among idea units, construct a coherent mental representation of text, and ultimately facilitate reading comprehension (Meyer & Ray, 2011). Since the late 1970s, the top-level structure has been widely adopted to the analysis of expository texts, because compared to narrative texts, expository texts are given more weight in schools and careers, and less likely to be influenced by text content (Davis, Lange, & Samuels, 1988).

There are five top-level structures of expository text, which are compare/contrast, problem-and-solution, cause-and-effect, sequence and description (Meyer, 1985). Comparison/contrast is used to relate ideas by differences or similarities, problem/solution encompasses problem and its corresponding solutions, cause/effect relates ideas with causal relationships, description includes ideas of a topic by elaborating "attributes, specifics, manners, or settings" and sequence lists events by numerical or temporal order (Meyer, 1985, p. 17). Using the five rhetorical relations at the top-level structure, readers are capable of categorizing different types of expository texts and producing similar patterns of recall for texts with identical structure but different content (Meyer & Rice, 1984).

Research has revealed that the structure of expository text plays an important role in readers' storing and retrieving information. Meyer and McConkie (1973) proposed that readers' retention of an idea could be influenced by the position of the idea as to the structure of the text. To be specific, ideas higher in the hierarchical structure have a higher probability to be recalled and can serve as the cues for ideas at lower levels. Meyer (1975) elaborated this finding by concluding that, the position of information in the structure was a significant predictor of how well information was recalled; meanwhile, information at lower levels would be remembered to a lesser degree and more easily forgotten over time. Meyer and Freedle (1984) found that more organized structures (i.e., compare/contrast, problem/solution, cause/effect) were expected to

yield superior recall of information compared with less organized structure (i.e., sequence and description) even if the same amount of information was contained.

Furthermore, students were found to differ in their ability in identifying appropriate structures of expository texts and using the structure to facilitate recalls. For example, Meyer, Brandt, and Bluth (1980) found less than 25% of ninth graders managed to use the structure strategy consistently during reading assessments; and more importantly, students with higher reading ability tended to use the structure strategy more often and recalled more information than their counterparts with poor reading ability. They concluded that identifying and using proper text structure accounted for 44% of the variance in immediate recalls and 68% in delayed recalls. Taylor (1980) also concluded that advanced readers had superior recalls than poor readers in sixth grade, and this disparity was partly attributed to the use of appropriate text structure. It appeared that good readers tended to use top-level structure to organize their recalls whereas poor readers resorted to the default strategy by listing a collection of information. However, it was noted that even good readers may not use the structure strategy consistently for recalls. College students were also found to have varied proficiency in recognizing text structure and producing recalls accordingly, and this proficiency was related to their general comprehension ability (Hiebert, Englert, & Brennan, 1983).

Early research on text structure strategy and its effects on memory and learning suggests that on the one hand, the organization of expository text influences readers' processing of the text; and on the other hand, using appropriate structure to organize recalls is likely to improve the quantity and quality of recalls. Nevertheless, as readers vary in their ability to recognize and use the text structure while reading, instructions about using the structure strategy are encouraged to be delivered to readers in schools.

2.1.2 Structure Strategy Instruction and Reading Comprehension

Research of the structure strategy interventions has been conducted since the 1970s and consistently shown positive effects on researcher-designed and standardized reading outcomes. Empirical studies have revealed a promising main effect on reading outcomes for participants from preschoolers to old adults, and researchers have examined the moderating role of many factors including types of outcome measure (Taylor, 1982), readers' familiarity with the content (Taylor & Beach, 1984), general reading ability (Armbruster, Anderson, & Ostertag, 1987; Meyer et al., 2010), the importance of information (Cook & Mayer, 1988), use of signaling words (Meyer & Poon, 2001), and instructional designs (Hebert et al., 2016) on the efficacy of the structure strategy interventions.

Instructions delivered to students in the later grades of the elementary and secondary school offered consistent evidence for the positive impacts on reading outcomes. Bartlett (1978) provided the earliest structure strategy instruction to high school students (i.e., ninth graders) and concluded that adopting the top-level structure to organize recalls explained 56.9% of the variance in posttest recalls, with effect retained over three weeks. Taylor (1982) taught elementary school students (i.e., fifth graders) to produce a hierarchical summary of expository texts. Results showed that both the treatment and prior general ability were predictive of the recalls, but no significant interaction between treatment and reading ability was found. Nevertheless, there was no treatment effect on short-answer questions, suggesting that the efficacy of structure strategy instruction may be dependent on the outcome measures. Taylor and Beach (1984) provided 7-week instruction to seventh graders and found that first, it only had significant treatment effects on recalls of unfamiliar content, and second, it had an indirect effect on students' writing skills via recall. Armbruster, Anderson and Ostertag (1987) stated that the structure strategy instruction had universal effects on fifth graders' performances in essay

question tasks regardless of general reading ability, whereas favoring higher ability students on summarization tasks.

Similar results were found for college students who received 9-hour instruction of structure strategy (Cook & Mayer, 1988). That is, students in the treatment group showed higher gains in the recall and standardized comprehension test. Nevertheless, the gains were substantially higher in recalling superordinate than subordinate information, and in answering application questions than literal questions. Meyer and Poon (2001) examined the effects of structure strategy instruction and signaling words on the recalls by providing a 9-hour training to young and old adults. Results showed that readers benefited from the instruction of using the structure strategy instead of instruction with an interest-focused listing strategy or no instruction in the wait-like control group. Structure strategy treatment group had superior recall for total information, the most important information, and top-level structure. Similar findings were shown with young and older adults randomly assigned to the structure strategy or recall practice or wait-list control groups (Meyer, Young, & Bartlett, 1989). However, more importantly, Meyer and Poon's (2001) findings suggested that providing structure strategy instruction and signaling words had an additive effect on readers' consistent use of the structure strategy and recalls.

Studies have also been extended to primary grades in elementary school and pre-school. Williams and her colleagues (e.g., Williams, 2005; Williams et al., 2007; Williams et al., 2009; Williams et al., 2014; Williams et al., 2016) implemented a couple of experiments to investigate the impacts of teaching the structures of compare/contrast and cause/effect to primary grades students with learning disabilities. Results provided evidence for the positive impacts on explicitly taught outcomes as well as transfer tasks when compare/contrast structure was used (Williams, 2005; Williams et al., 2009). However, the effect on transfer tasks was not evident when cause/effect structure was recalled in one of their earlier studies (Williams et al., 2007). Later research (Williams et al., 2014; Williams et al., 2016) disconfirmed this finding and

concluded that students performed better on both taught and novel texts with cause/effect structure. The previous results of the lack of transfer effect could be attributed to using less-structured text in the test. In general, primary grade students can benefit from the structure strategy instruction without losing the amount of content they acquired in the traditional content-based programs. For pre-school children, Culatta, Hall-Kenyon, and Black (2010) found children aged 4 to 5 improved their awareness of compare/contrast and problem/solution when the instruction of structure strategy was delivered through conversation.

In addition to traditional classroom instructions, the intelligent tutoring system has been adopted to deliver the structure strategy to learners from fourth to eighth grades. Moderate to large effects for treatment was found on researcher-designed recall measures, whereas small effect was found on standardized reading assessment (e.g., Meyer et al., 2002; Meyer et al., 2010; Meyer, Wijekumar, & Lin, 2011; Meyer, Wijekumar, & Lei, 2018; Wijekumar et al., 2014; Wijekumar, Meyer, & Lei, 2012, 2017; Wijekumar et al., 2017). The Intelligent Tutoring of the Structure Strategy (ITSS) provides an interface with which students can interact to learn, practice, and receive feedback. Compared with human tutor instruction, the intelligent tutoring system offers more individualized instruction to each student (Ma, Adesope, Nesbit, & Liu, 2014; Meyer et al., 2010). Several findings were noteworthy about the efficacy of ITSS on reading outcomes. First, ITSS instruction was found to have significant effects on researcher-designed measures and standardized measures for fifth- and seventh-grade students (Wijekumar et al., 2014; Wijekumar, Meyer, & Lei, 2017; Wijekumar et al., 2017). However, there was no significant effect on standardized reading measures for fourth graders (Wijekumar et al., 2014). Second, results showed that instructional design factors could potentially moderate the efficacy of ITSS on standardized reading tests (Meyer et al., 2010; Meyer et al., 2011). That is, students tended to gain more after receiving elaborated feedbacks than simple feedbacks and made greater progress when delivered individualized instruction than standard instruction. Third, ITSS instruction

facilitated students' generating and using accurate compare/contrast signaling words, although the effects were dependent on students' grade level, reading ability, and signaling words tested (Meyer et al., 2018).

Meyer and Ray (2011) wrote a systematic review of the structure strategy instructions between 1978 and 2011. Studies have been classified in terms of time (e.g., early and recent), participant age (e.g., pre-school, elementary school, high school, college students, young and old adults) and language (e.g., French, Spanish, Dutch). They concluded that there was substantial and consistent evidence for the effectiveness of structure strategy instructions, that is to increase readers' recalls from expository texts in terms of both quantity and quality. Structure strategy instruction also increased the reader's abilities to use signal words, produce main ideas and summaries, and eventually facilitate reading comprehension measured by standardized tests or short answer questions. However, they noted that instructions should be adaptive to the readers' age and need in particular developmental phases.

Hebert, Bohaty, Nelson, and Brown (2016) conducted a meta-analysis to explore the impacts of structure strategy instruction on expository reading comprehension. Through reviewing 45 studies involving students in Grades 2 to 12, they calculated the effect size for researcher-designed measures ($d = 0.57$), near transfer tasks ($d = 0.62$) and far transfer tasks ($d = 0.15$). Moderation analysis suggested that teaching more types of text structures, involving writing tasks in the instruction, and including a competing instruction were expected to enhance the efficacy of the structure strategy interventions.

In general, previous studies have examined closely on the main effects of structure strategy instruction, as well as the moderating effects of readers' characteristics, instructional design, and testing materials on reading outcomes; however, only a few studies took into account of motivational factors concerning the structure strategy instruction. Motivation plays an important role in learning because it "initiates, directs, energizes, sustains, and terminates

actions" (Graham & Weiner, 2012, p. 367). Connections between motivational factors and academic achievement have been found many studies, particularly in the domains of reading and mathematics. Among the motivational constructs, self-efficacy has been explored extensively in terms of its association with cognitive, affective, and behavioral outcomes (Ahn & Bong, 2019).

Topic interest and self-efficacy have been examined in the previous research. Results indicated that the structure strategy instruction had a significant direct effect on students' self-efficacy (Meyer et al., 2002; Wijekumar et al., 2014). Meyer et al. (2002) randomly assigned fifth-grade students to three groups, an online tutoring program with old adult tutors, an online tutoring program without tutor, and business-as-usual groups. They found that the structure strategy group with the human tutor not only outperformed the other two groups on the text recall but also on general self-efficacy and social self-efficacy, suggesting that human tutoring of the structure strategy may improve students' self-efficacy. Wijekumar et al. (2014) examined the impacts of ITSS on structure strategy self-efficacy, reading self-efficacy, and learning self-efficacy. Results showed that on the one hand, the instruction had a significant direct effect on students' structure strategy self-efficacy and reading self-efficacy; and on the other hand, learning self-efficacy and reading self-efficacy significantly predicted reading comprehension. This study suggested a mediating relationship in which the instruction facilitated reading comprehension through improving students' reading self-efficacy, although the authors did not test the mediation model explicitly. Topic choice or interest was found to be an insignificant predictor of reading performances; to be specific, variance in reading outcomes was negligible regardless of whether a student chose between two offered topics for practicing the structure strategy (e.g., dogs or parrots) or a similarly matched reader was assigned the same topic as her linked pair without a choice of topic, as long as the same type of structure was embedded (Meyer et al., 2010).

In general, compared with considerable studies focused on academic outcomes, the current literature paid insufficient attention to the effect of structure strategy instruction on

motivational or affective outcomes even though they were found to correlate with reading outcomes. Drawing insights from the previous research (Meyer et al., 2002; Wijekumar et al., 2014), this study explores how and for whom ITSS instruction influences reading comprehension and self-efficacy.

2.2 Self-efficacy and Reading Comprehension

2.2.1 Self-efficacy

The social cognitive theory proposes that humans play an agentic role in taking actions and achieving goals instead of being solely controlled by the external environment (Bandura, 2001). Bandura (1986, 1997) posited a model of triadic reciprocal relationships among behavior, internal person factors (e.g., cognitive, affective, biological states), and external environment (e.g., economic conditions, socioeconomic status, family environment). Any one of the three is not only influenced but also contributing to the other two. That is, a person's behavior would on the one hand, be influenced by his cognitive, affective, biological states and environmental events; and on the other hand, exert influence on his internal states and external environment. It is noted that the reciprocal relationship should be explained contextually (Bandura, 1997).

Social cognitive theorists are interested in factors that regulate or motivate an individual's performances in cognition, social interaction and behavior, and among these factors great importance is attached to self-efficacy because it is expected to impact one's choice of activities and motivation, which in turn influence the outcomes (Bandura, 1997). To be specific, people with high self-efficacy would react more positively in the face of challenges and failures, put more effort into tasks, and feel more motivated and engaged in activities that they perceived to be good at than perceived areas of failure (Bandura, 2001).

Self-efficacy is defined as an individual's belief or perception of his capability in fulfilling certain tasks that would impact his life (Bandura, 1977). It may or may not mirror his actual performance or skill though, as people could overestimate or underestimate their capacities due to several reasons (e.g., attributions to past experiences, temporal states). Moreover, a person's self-efficacy may vary by domain (e.g., history vs. math), by task (e.g., easy vs. difficult), and by situation. Bandura (1997) stated that some general measures of self-efficacy may be poor predictors of the outcomes because personal self-efficacy is not as static and global as disposition. Therefore, a well-designed measure of self-efficacy should be built based on the performance it is designed to assess and representative of task demands (Bandura, 1997).

Bandura (1977) hypothesized that perceived self-efficacy is originated and developed from four main sources: enactive mastery experience, vicarious experience, verbal persuasion, and physiological and affective states. Enactive mastery experience is regarded as the most powerful source of self-efficacy beliefs because desired outcomes can directly increase one's self-efficacy whereas undesired outcomes always undermine it. It is learners' interpretation and evaluation of the outcomes that build or revise their judgments of personal capabilities (Usher & Pajares, 2008). Factors such as task difficulty, amount of effort, and personal attribution to success or failure are likely to influence one's interpretations of their mastery experience (Bandura, 1997; Usher & Pajares, 2008). Individuals can also form or change self-efficacy through observing models who are more competent or similar to them. If they see models succeed with constant endeavor, their self-efficacy would be promoted, and they would be more likely to put effort into the task. Verbal persuasion, such as encouragement from others, is another way to improve one's self-efficacy although it may not be able to exert an enduring effect. Physiology and affective states can also lead to the fluctuation of one's self-efficacy, that is, positive state (e.g., low level of stress) promotes perceived self-efficacy whereas negative state (high level of stress) weakens it. In general, these four sources work together to construct people's self-efficacy,

but the weight of each source is dependent on personal and contextual factors (Usher & Pajares, 2008).

Substantial evidence has shown that self-efficacy is positively related with academic achievement across domains, and the strength of the association is moderated by grade level, achievement status, and self-efficacy measure in use (Bong, Cho, Ahn, & Kim, 2012; Honicke & Broadbent, 2016; Multon, Brown, & Lent, 1991). A meta-analysis of 59 studies (Honicke & Broadbent, 2016) concluded there was a moderate relationship ($r = .33$, $p < .0001$) between academic self-efficacy (ASE) and academic performance (e.g., GPA, course grades). To be more specific, there was moderate and significant correlation between course-specific self-efficacy and course grades ($r = .32$, $p < .01$); small and significant correlation between ASE and course grades ($r = .22$, $p < .01$); small yet insignificant correlation between general self-efficacy and course grades ($r = .14$, $p > .05$). Results also supported Bandura's suggestion of building contextualized self-efficacy measures.

The importance of self-efficacy lies in its intricate connections with other cognitive, motivational, affective, and academic outcomes. As fourth and fifth graders are at a critical stage of transitioning into reading expository texts (Wijekumar et al., 2012; Wijekumar et al., 2014), teachers and schools should help students build their confidence during the phase of skill development in addition to making academic progress.

2.2.2 Self-efficacy and Reading Comprehension

The relationship between self-efficacy and reading comprehension has been examined in multiple studies. For example, it was found that Hispanic students' reading self-efficacy was related to their comprehension of English texts (Kelley, Siwatu, Tost, & Martinez, 2015). A moderate correlation ($r = .53$, $p < .05$) between English reading self-efficacy and English reading

comprehension was reported. Bråten, Ferguson, Anmarkrud, and Strømsø (2013) concluded that science reading self-efficacy significantly predicts comprehension of multiple texts, after controlling for topic knowledge, word recognition, reading pattern, and reading task value. However, the study was based on relatively small sample size, 65 Norwegian tenth graders, thus the generalizability of the findings may be questionable. Lau (2018) probed into the impact of reading motivation (i.e., self-efficacy, extrinsic motivation, intrinsic motivation) on reading comprehension of Classical Chinese texts. The finding indicated that reading self-efficacy and extrinsic motivation significantly predicted reading comprehension of Classic Chinese texts.

Nevertheless, some studies concluded that self-efficacy did not predict reading comprehension. For example, Anmarkrud and Bråten (2009) found that reading self-efficacy did not predict reading comprehension significantly, after controlling for gender, topic knowledge, strategy use, past achievement and reading task value for Norwegian ninth-grade students. However, this study did not control for students' baseline level of reading comprehension but instead used students' self-reported general achievement in social studies. Similar results were shown in another study (Andreassen & Bråten, 2010) which stated reading self-efficacy did not significantly predict the comprehension of social studies text after controlling gender, topic knowledge, strategy use, prior achievement. The results may be explained by the specificity level of the self-efficacy measure, that is, researchers used general self-efficacy instead of task-specific self-efficacy measure (Bråten et al., 2013).

Whereas most of the researchers were interested in the predictive role of self-efficacy on reading achievement, a few studies explored the reciprocal relationship between the two. Guthrie et al. (2007) investigated the reciprocal relationship between motivational factors (e.g., interest, involvement, self-efficacy) and reading comprehension for fourth-grade students. Results showed that on the one hand, reading self-efficacy did not significantly predict reading comprehension gains; on the other hand, reading comprehension did not significantly predict general motivation

development. However, they did not report the extent to which reading comprehension influenced the growth of self-efficacy per se. Hornstra, Van Der Veen, Peetsma, & Volman (2013) found that even though the initial levels of self-efficacy did not predict the growth of reading comprehension, the development in self-efficacy had a positive correlation with the development in reading comprehension. Sitzmann and Yeo (2013) conducted a meta-analysis and found there was a stronger correlation between past performance and current self-efficacy (r = .40) than between self-efficacy and subsequent self-efficacy (r = .23). They concluded that people should first increase self-efficacy based on past performances and then improve subsequent performances due to increased self-efficacy. Burns, Crisp, and Burns (2019) found there was a reciprocal relationship between course scores and course self-efficacy using longitudinal data.

In general, although the correlation between self-efficacy and reading comprehension has been confirmed by several studies, the directional influences of one on the other as well as the reciprocal relationship remain unclear. In fact, since many studies used cross-sectional design without taking into account of the baseline status, the directional inference may be questionable. As such, more evidence is needed regarding the relationship between self-efficacy and reading comprehension using the longitudinal design.

2.3 Research Questions and Hypotheses

Given the literature review, we found that the structure strategy instruction had positive impacts on the fifth graders' self-efficacy (Wijekumar et al., 2014). However, the way that structure strategy instruction influenced self-efficacy remains ambiguous. As past mastery experience serves as the most powerful source of self-efficacy (Bandura, 1997), it is worthwhile to examine whether and how reading performance interferes with the relationship between the instruction and self-efficacy. Meanwhile, Hornstra et al. (2013) found that baseline reading

performance was predictive of the growth of self-efficacy, indicating that the impact of instruction on self-efficacy may be dependent on students' initial level of reading comprehension. As such, we are interested in exploring whether reading comprehension mediates or moderates the effect of structure strategy instruction on self-efficacy.

Similarly, whereas considerable research concluded that the structure strategy instruction had positive impacts on reading comprehension, the role of self-efficacy has been rarely explored concerning its influence on the growth of reading comprehension. Given the predictiveness of self-efficacy on reading comprehension (Bråten et al., 2013), we are also interested in finding out whether self-efficacy mediates or moderates the impact of structure strategy instruction on reading comprehension.

Specifically, we intend to examine the interrelationships among ITSS instruction, an Internet-based intelligent tutoring system designed to deliver structure strategy instruction, self-efficacy (i.e., structure strategy self-efficacy, reading self-efficacy, learning self-efficacy), and reading comprehension. Four research questions are proposed as follows:

(1) Does reading comprehension mediate the effect of ITSS instruction on self-efficacy in structure strategy, reading and learning?

(2) Does prior reading comprehension moderate the effect of ITSS instruction on self-efficacy in structure strategy, reading and learning?

(3) Does self-efficacy in structure strategy, reading and learning mediate the effect of ITSS instruction on reading comprehension?

(4) Does prior self-efficacy in structure strategy, reading and learning moderate the effect of ITSS instruction on reading comprehension?

First, ITSS instruction is hypothesized to have a positive impact on learners' reading comprehension, which in turn improves self-efficacy. It is noted that the strength of the correlation between self-efficacy and reading comprehension may vary when different measures

of self-efficacy are used (Bandura, 1997). Therefore, ITSS instruction is expected to have the largest indirect impact on reading self-efficacy, followed by structure strategy self-efficacy, and learning self-efficacy. Since learning self-efficacy is domain-general, it is expected to gain the smallest growth after the treatment and has the weakest association with reading comprehension.

Second, the impact of ITSS instruction on self-efficacy is hypothesized to vary across learners with different baseline levels of reading comprehension. Although Unrau et al. (2018) did not find that prior reading performance significantly moderated the effect of interventions on reading self-efficacy, they suggested struggling learners gained more from the treatment than non-struggling. Therefore, I would expect students with lower prior reading skills to show more growth in their self-efficacy after the ITSS intervention.

Third, ITSS instruction is hypothesized to exert an indirect effect on learners' reading comprehension through the growth of self-efficacy. Studies (Benson, 1989; Relich, Debus, & Walker, 1986; Schunk, 1981) suggested that interventions may influence academic achievement through the growth of self-efficacy, therefore I expected self-efficacy to be a significant mediator for the effect of ITSS instruction on reading comprehension. For the same reason, the indirect impact of ITSS on reading comprehension via reading self-efficacy is expected to be stronger than structure strategy self-efficacy and learning self-efficacy.

Fourth, ITSS instruction is hypothesized to exert varied impacts on learners' reading comprehension given the baseline levels of self-efficacy. Specifically, students with lower reading self-efficacy are assumed to benefit more from ITSS instruction, as treatment may lead them to realize that they can resolve comprehension problems by adopting appropriate strategies and therefore less affected by self-doubting thought (Bouffard-Bouchard, 1994).

Finally, I would hypothesize there is a reciprocal relationship between reading comprehension and self-efficacy, and the bidirectional relationship would be strongest between reading comprehension and reading self-efficacy, because the specificity of reading self-efficacy

is particularly relevant to reading comprehension compared with structure strategy self-efficacy and learning self-efficacy.

Chapter 3

Methods

This chapter describes the methods of the study, which include the study design and data analyses. Participants, measures and procedures of ITSS instruction are presented in the first section; mediation and moderation models, preliminary analyses and hypothesized models are discussed in the second section.

3.1 Study Design

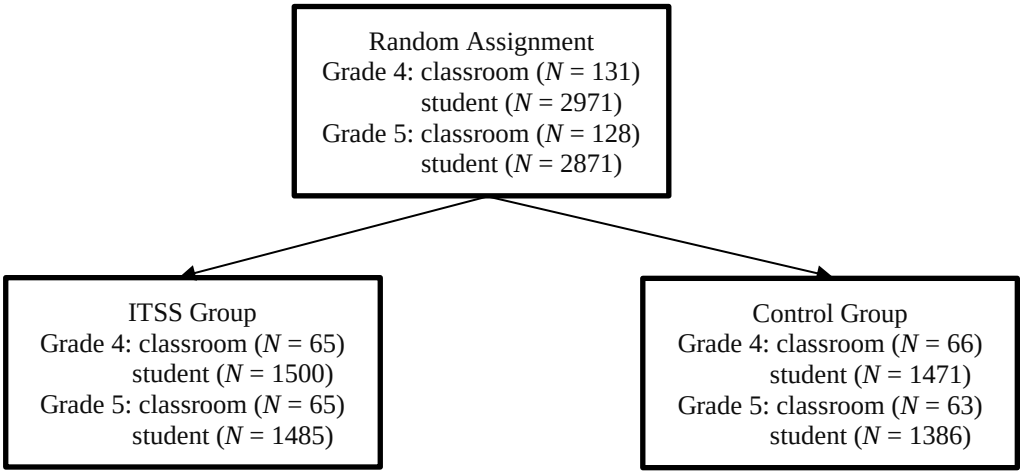
A multisite randomized controlled trial (CRT) design was used to examine the effects of ITSS instruction on fourth- and fifth-grade students' self-efficacy and reading comprehension (Wijekumar et al., 2012; Wijekumar et al., 2014). That is to say, classrooms within each school were randomly assigned to the ITSS and business-as-usual groups, and students in the classroom were automatically assigned to one of the experimental conditions. This type of research design ensured curriculum consistency, and the requirement of password to access the ITSS program lowered the risk of contamination between the ITSS and control group (Wijekumar et al., 2012).

3.1.1 Participants

This study used secondary data collected by the ITSS research team during October 2009 and April 2010. Participants were 5842 students in fourth and fifth grades from 45 elementary schools in Northeastern US. A total of 131 fourth-grade classrooms were randomly assigned to either the ITSS instruction (N = 65) or control group (N = 66), and 128 classrooms at fifth grade were randomly assigned to one of the experimental conditions, 65 classrooms in the ITSS

instruction and 63 in the control group. At the student level, a total of 2971 fourth graders were randomly assigned to receive ITSS instruction (N = 1500) or regular language arts curriculum (N = 1471), and 2871 fifth graders were assigned to either the treatment group (N = 1485) or the control group (N = 1386). The random assignment at the classroom and student level is illustrated in Figure 3.1.

Figure 3. 1 Random Assignment of Classrooms and Students



Teachers in the ITSS instruction group received professional trainings on using ITSS program and were instructed not to share any ITSS materials with their colleagues in the control group due to potential risks of intervention diffusion (Wijekumar et al., 2012; Wijekumar et al., 2014). Teachers and students in the control group were accessible with the same ITSS lessons in the subsequent academic year (Wijekumar et al., 2012). Consent forms from parents and teachers were signed to be participants of the study (Wijekumar et al., 2012; Wijekumar et al., 2014).

3.1.2 Measures

Reading comprehension and self-efficacy were assessed at the pretest and posttest. Reading comprehension was measured using the Gray Silent Reading Test (GSRT; Wiederholt &

Blalock, 2000), a norm-referenced assessment of the silent reading comprehension for individuals aged from 7 through 25. Two parallel forms of GSRT were used, Form B in the pretest and Form A in the posttest. Each form contains 13 short stories with 5 multiple-choice questions followed. Both forms showed considerably high internal consistency (Cronbach's $\alpha = .95$ for Form A; Cronbach's $\alpha = .94$ for Form B) (Wiederholt & Blalock, 2000). Grade equivalent scores, ranged from 0 to 18, were used in the statistical analysis.

Self-efficacy was measured using three subscales of self-efficacy, which are structure strategy self-efficacy, reading self-efficacy, and learning self-efficacy adapted from previous studies after applying factor analysis to reduce the testing burden in school (Meyer et al., 2002, 2010). Five items were created by the research team to assess students' self-efficacy in using the structure strategy, for example, to summarize main ideas when an expository text was given (Meyer, 2009). Four items of reading self-efficacy were adapted from the Reader subscale of Motivation to Read Profile (Gambrell, Palmer, Codling, & Gambrell, 1996). Specifically, these items were designed to assess one's perceived competence as a reader. Five items of learning self-efficacy were adapted from the general self-efficacy scale to assess one's persistence through hard learning tasks (Sherer & Maddux, 1982). Sample items for each subscale are displayed in Table 3.1.

Students rated their self-efficacy beliefs using the 4-point scale, with 4 indicating the highest level and 1 the lowest level of perceived competence. The composite score for each subscale was used in the analysis to represent students' efficacy judgments in structure strategy, reading, and learning. Reliability estimates for each subscale are presented in Table 3.2. Acceptable internal consistency was reported for structure strategy self-efficacy and reading self-efficacy (Cronbach's $\alpha > .70$) whereas the internal consistency for learning self-efficacy was relatively low (Cronbach's $\alpha < .70$) (Wijekumar et al., 2014).

Table 3. 1 Sample Items for Self-efficacy Measures

	Item	Score
Structure Strategy Self-efficacy (Meyer, 2009)	I could write the correct words for the four blanks in the article.	
	Not sure.	1
	A little bit sure.	2
	Somewhat sure.	3
	Really sure.	4
Reading Self-efficacy (Gambrell et al., 1996)	When I am reading by myself, I understand _____.	
	very hard for me.	1
	kind of hard for me.	2
	kind of easy for me.	3
	very easy for me.	4
Learning Self-efficacy (Sherer & Maddux, 1982)	I avoid trying to learn new things when they look too difficult for me.	
	Totally.	1
	Pretty much.	2
	A little.	3
	Not at all.	4

Table 3. 2 Reliability Estimates for Self-efficacy Measures

Measures	Reliability Estimates			
	Grade 4		Grade 5	
	Pretest	Posttest	Pretest	Posttest
Structure Strategy Self-efficacy	.74	.71	.75	.75
Reading Self-efficacy	.73	.73	.77	.78
Learning Self-efficacy	.68	.58	.62	.62

3.1.3 Procedures

The standardized test of reading comprehension and self-efficacy questionnaires were administered for the ITSS and control groups before and after the intervention. Both fourth- and fifth-grade students in the ITSS group received instruction of structure strategy for 30 to 45 minutes each week over 6 to 7 months, while students in the control group maintained their language arts curriculum with the same instruction time as the ITSS group (Wijekumar et al., 2012; Wijekumar et al., 2014).

The goal of ITSS lessons is to teach students to apply structure strategies to diverse contexts and ultimately improve comprehension of expository texts (Wijekumar et al., 2012). Five top-level structures (i.e., compare/contrast, problem/solution, cause/effect, sequence, description) were introduced, elaborated, and practiced during the instruction, with 12 lessons for each structure. The instruction was delivered through an intelligent tutor which can provide modeling and practice to locate signaling words, identify appropriate text structure and summarize main ideas of the text (Wijekumar et al., 2012). For example, students were taught that “however”, “in contrast”, and “instead” are commonly used as the signaling words in the structure of compare/contrast; “as a result”, “for the purpose of”, and “in order to” indicate a pattern of cause/effect; “afterward”, “to start with”, and “following” demonstrate sequential organization (Meyer et al., 2002). After modeling, students were presented with an expository text with the same top-level structure and asked to identify the type of text structure, fill in diagrams or tables that summarize main ideas, and ultimately recall the text (Wijekumar et al., 2012; Wijekumar et al., 2014). Scores for each step were shown instantly along with feedbacks, for instance, if a student failed his first trial, the words “try again” would pop up; and if they failed more than five times, I. T. would show him correct answers and let him try a new text (Wijekumar et al., 2014). During the intervention, teachers were monitoring students to prevent

them from playing with the program and providing assistance, and meanwhile the fidelity of implementation was ensured by computer logs and classroom observations (Wijekumar et al., 2014).

3.2 Data Analytics

To address the four research questions, structural equation modeling (SEM) was adopted to conduct mediation and moderation analyses. Compared with traditional statistical techniques (e.g., ANOVA, multiple linear regression, hierarchical linear modeling), SEM estimates multiple equations simultaneously and can handle latent variables (Kline, 2016). The SEM analyses were conducted separately for fourth- and fifth-grade students due to a couple of reasons. First, practice tasks of full recall were dropped from the ITSS lessons for fourth graders because their teachers complained about too much typing for children (Wijekumar et al., 2012). Second, grade equivalence scores were used to measure students' reading comprehension and mixing up results of both grades could lead to misinterpretation. Third, fourth- and fifth-grade children have different levels of exposure to expository texts, therefore it is more reasonable to analyze the results separately.

The mediation and moderation models posited in this study are first introduced with an emphasis on the advantages of the half-longitudinal mediation model over alternative models. This section is followed by preliminary analyses including assumption check and selection of estimation techniques and ends with descriptions of four hypothesized models in correspondence with research questions.

3.2.1 Mediation and Moderation Models

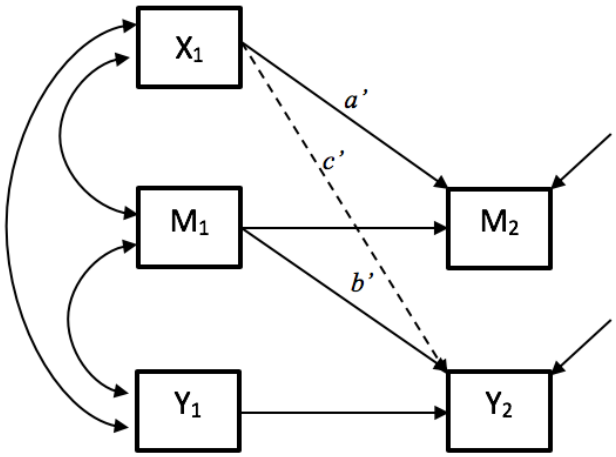
Mediation refers to the mechanism in which one variable exerts an influence on another variable through the third one; to be more specific, an independent variable (X) influences another variable (M) which in turn changes the outcome variable (Y). Three effects are discussed in the mediation analysis, which are total effect, direct effect and indirect effect (Cole & Maxwell, 2003). The direct effect shows how X influences M (path *a*), M influences Y (path *b*), and X influences Y (path *c*). The indirect effect demonstrates how X influences Y through M, which is equal to the product of path *a* and path *b*. The total effect is the sum of direct and indirect effects, which is $ab + c$. These are conceptual and statistical representations for a simple mediation model; however, doubts have been raised on the plausibility of the mediation model with cross-sectional design (Cole & Maxwell, 2003).

Cole and Maxwell (2003) argued that mediation involves at least two causal relations and one approach to infer causality between two variables is to measure one variable before the other. Little (2013) stated that by using the cross-sectional design, the prior level of outcomes can hardly be measured and controlled; therefore, the longitudinal design would be more appropriate to test the mediation model. With data collected at multiple occasions, the longitudinal mediation models can provide stronger evidence for causal relations by considering prior performance and thus potentially allow for making more rigorous inferences (Little, 2013).

Cole and Maxwell (2003) proposed the half-longitudinal mediation model and longitudinal model. The half-longitudinal mediation model allows for data collected at two time points whereas the longitudinal mediation model requires measures on at least three occasions. The basic half-longitudinal mediation model, as depicted in Figure 3. 2 (Kline, 2016), shows that the exogeneous variable X_1 was collected at Time 1, the meditating variable M and the outcome variable Y were collected at both Time 1 and Time 2. Path *a'* is estimated by the regression of M_2

on X_1 after controlling for M_1, and path *b'* is estimated by the regression of Y_2 on M_1 after controlling for Y_1. As such, the cross-product *a'b'* represents the indirect effect of X_1 on Y_2 through M. Path *c'* (the dashed line) represents the direct effect of X_1 on Y_2 controlling for Y_1.

Figure 3. 2 The Half-longitudinal Mediation Model

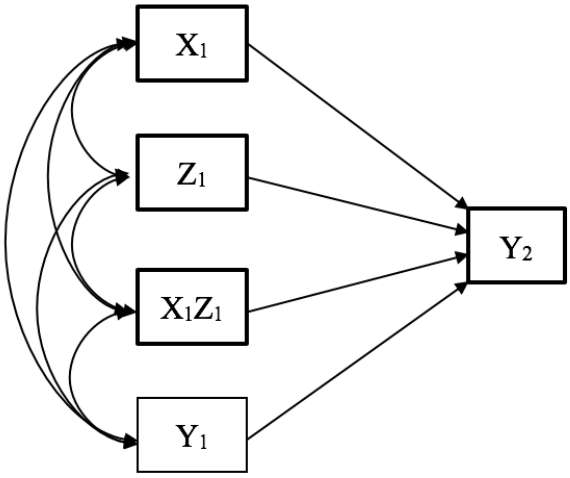


Cole and Maxwell (2003) stated two approaches to test the indirect effect. The first approach is to test path *a'* and *b'* separately, and if *a'* and *b'* are significantly different from zero, then their product is nonzero. The second approach is to test the cross-product *a'b'* directly, and if *a'b'* is significantly different from zero, the argument that M mediates the effect of X_1 on Y_2 is supported. Little (2013) suspected the reasonability of the first approach and proposed various ways to test the significance of cross-product *a'b'*. One of the approaches is to use bootstrapping to generate a less biased standard error of *a'b'*. With bootstrapped samples, the confidence interval of the product *a'b'* can be calculated to determine the significance of *a'b'*.

Moderation describes a mechanism in which a moderator variable (Z_1) either weakens or strengthens the effect of an exogenous variable (X_1) on the outcome variable (Y_2). That is to say, if the effect of X_1 on Y_2 depends on the level of Z_1, the moderating role of Z_1 is supported. To test the moderation model with cross-sectional data, one only needs to test the significance of the

interaction between X_1 and Z_1; however, it is more challenging to test it with longitudinal data. Little (2013) noted that, for the significance test of moderation, the interaction should be correlated with other variables at all time points in the model except for the regression path in which the interaction predicts the outcome at a later time. The diagram of the moderation model with two time points is shown in Figure 3. 3 (Kline, 2016). The parameter of the path which points from X_1Z_1 to Y_2 is estimated to determine the significance of the moderating effect.

Figure 3. 3 The Moderation Model



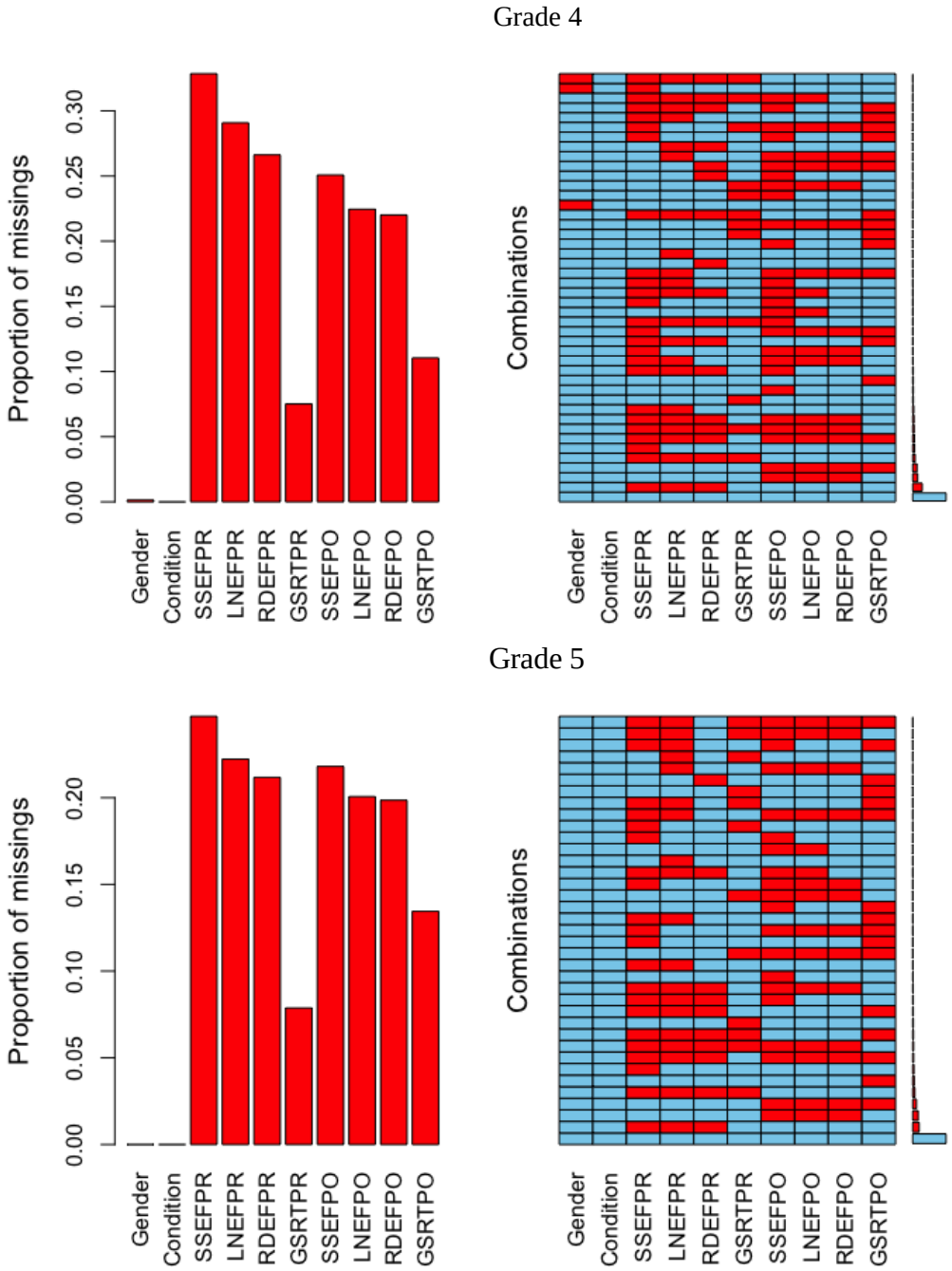
3.2.2 Preliminary Analyses

Preliminary analyses were carried out to select the optimal estimators for the SEM analyses. There were high percentages of missing values on GSRT scores (7.5% - 11.0%) and self-efficacy ratings (22.0% - 32.9%) for fourth graders. The missing values were not completely at random (Little's $\chi_2 = 223.393$, $df = 176$, $p < .05$). A similar pattern was exhibited for fifth graders, 7.9% to 13.4% missing on GSRT scores and 19.9% to 24.7% were missing on self-efficacy ratings. The missing was not completely at random (Little's $\chi_2 = 299.708$, $df = 161$, $p < .05$). The missing pattern is presented in Figure 3.4.

Univariate distributions of all the continuous variables were found non-normal for Grade 4 and 5. All of the self-efficacy ratings were negatively skewed whereas GSRT scores were positively skewed, as shown in Figure 3.5. Shapiro-Wilk tests also suggested the assumption of normality was not met for both grade levels. Boxplots showed that less than 1% of the students had extremely low scores (i.e., lower than Q1 – 1.5 IQR) on self-efficacy ratings and less than 1% had extremely high GSRT scores (i.e., higher than Q3 + 1.5 IQR).

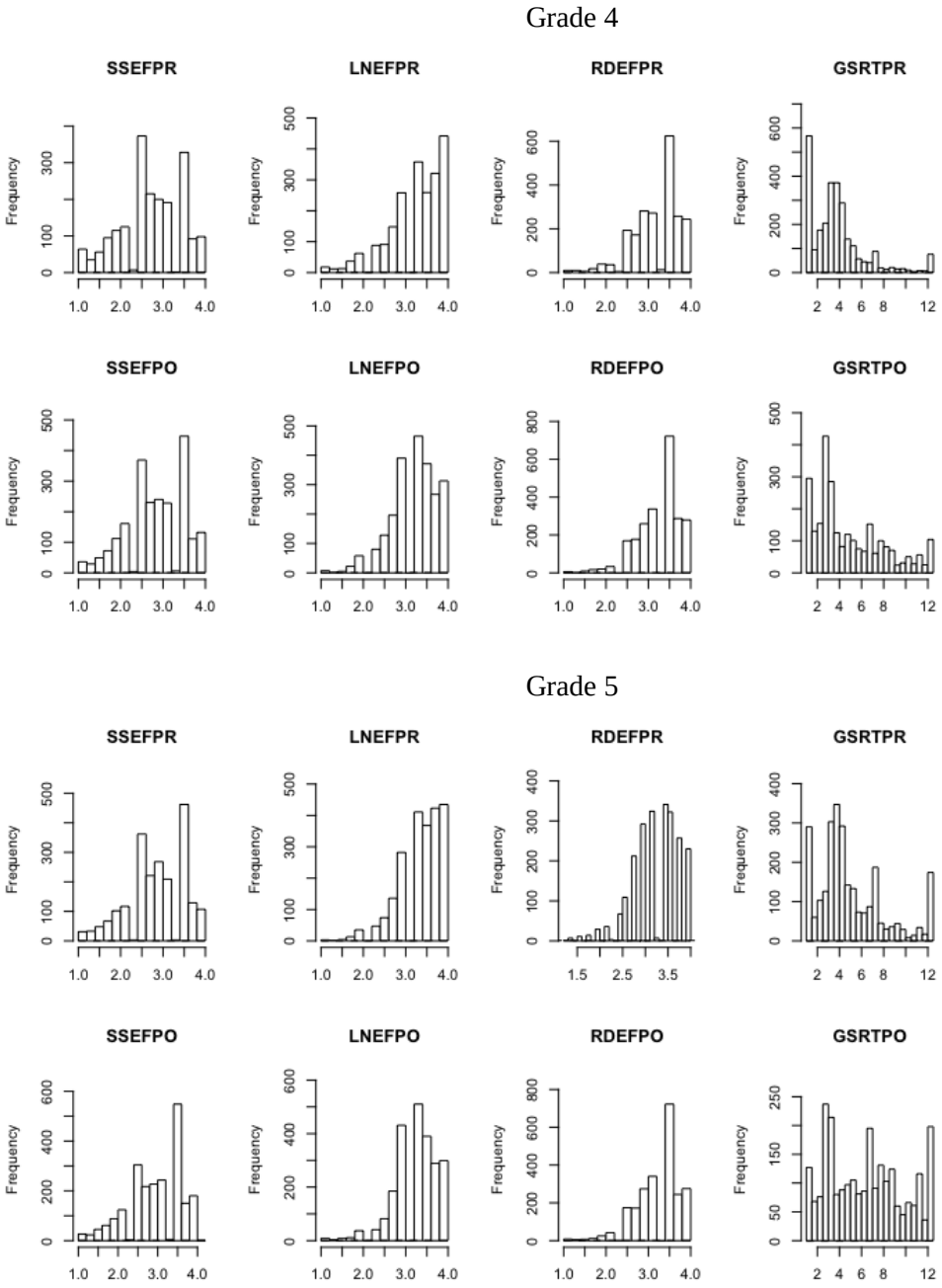
The correlation matrix, shown in Figure 3.6, suggested that GSRT scores and self-efficacy ratings were moderately correlated at pretest and posttest. There was no indication of multicollinearity among measures ($r < .800$). Reading self-efficacy at the pretest had the highest correlation with reading self-efficacy at posttest ($r = .566$) for Grade 4, whereas learning self-efficacy at the pretest had the highest correlation with learning self-efficacy at posttest ($r = .639$) for Grade 5. The condition had small and insignificant correlations with all the other measures except for GSRT scores at posttest.

Figure 3. 4 Missing Data Pattern for Grade 4 and 5



Note. *N* = 2971 for Grade 4, *N* = 2871 for Grade 5. Gender = 0 (Male), Gender = 1 (Female). Condition = 0 (control group), Condition = 1 (ITSS group). SSEFPR = structure strategy self-efficacy pretest, RDEFPR = reading self-efficacy pretest, LNEFPR = learning self-efficacy pretest, GSRTPR = the Gray Silent Reading Test pretest, SSEFPO = structure strategy self-efficacy posttest, RDEFPO = reading self-efficacy posttest, LNEFPO = learning self-efficacy posttest, GSRTPO = the Gray Silent Reading Test posttest.

Figure 3. 5 Histogram of the Measures for Grade 4 and 5



Note. *N* = 2971 for Grade 4, *N* = 2871 for Grade 5. SSEFPR = structure strategy self-efficacy pretest, RDEFPR = reading self-efficacy pretest, LNEFPR = learning self-efficacy pretest, GSRTPR = the Gray Silent Reading Test pretest, SSEFPO = structure strategy self-efficacy posttest, RDEFPO = reading self-efficacy posttest, LNEFPO = learning self-efficacy posttest, GSRTPO = the Gray Silent Reading Test posttest.

Table 3. 3 Correlations among Pretest and Posttest Measures for Grade 4 and 5

Grade 4

Measures	1	2	3	4	5	6	7	8	9
1. ITSS	1								
2. SSEFPR	.020	1							
3. RDEFPR	.002	.481**	1						
4. LNEFPR	.019	.332**	.403**	1					
5. GSRTPR	.002	.209**	.343**	.258**	1				
6. SSEFPO	.041	.450**	.384**	.283**	.280**	1			
7. RDEFPO	.012	.361**	.566**	.284**	.335**	.490**	1		
8. LNEFPO	.021	.235**	.337**	.384**	.237**	.374**	.395**	1	
9. GSRTPO	.049*	.214**	.336**	.255**	.492**	.333**	.366**	.272**	1

Grade 5

Measures	1	2	3	4	5	6	7	8	9
1. ITSS	1								
2. SSEFPR	.019	1							
3. RDEFPR	.017	.369**	1						
4. LNEFPR	-.006	.528**	.380**	1					
5. GSRTPR	.032	.280**	.210**	.381**	1				
6. SSEFPO	.019	.476**	.289**	.435**	.306**	1			
7. RDEFPO	.006	.234**	.424**	.300**	.194**	.387**	1		
8. LNEFPO	.025	.413**	.333**	.639**	.385**	.612**	.392**	1	
9. GSRTPO	.093**	.280**	.240**	.385**	.519**	.350**	.219**	.419**	1

Note. N = 2971 for Grade 4, N = 2871 for Grade 5. ITSS = Intelligent Tutoring of Structure Strategy, SSEFPR = structure strategy self-efficacy pretest, RDEFPR = reading self-efficacy pretest, LNEFPR = learning self-efficacy pretest, GSRTPR = the Gray Silent Reading Test pretest, SSEFPO = structure strategy self-efficacy posttest, RDEFPO = reading self-efficacy posttest, LNEFPO = learning self-efficacy posttest, GSRTPO = the Gray Silent Reading Test posttest. * $p < .05$, ** $p < .01$, *** $p < .001$.

M*plus* version 8.3 (Muthén & Muthén, 2017) was used to test the mediation and moderation models. Maximum Likelihood (ML) approach was applied to estimate parameters based on observed covariances (Kline, 2016). Given the missing values and non-normality of the data, MLR (Robust Maximum Likelihood) was chosen as the optimal estimator, as it can provide full-information maximum likelihood (FIML) estimation with robust standard errors and handle missing data well (Asparouhov & Muthén, 2005; Enders, 2001; Maydeu-Olivares, 2017). Bootstrapping (i.e., Bootstrapping = 500) was also used to obtain the standard error of indirect effects because it can give less biased estimates to non-normal and large sample data (Kline, 2016).

Given that CRT design was used in the study, the cluster effect of classroom and school was taken into consideration. The M*plus* command "TYPE = COMPLEX" was used to estimate standard errors and conduct Chi-square Test of model fit, because it can handle stratification, non-independence of observations, and unequal probability of selection well (Muthén & Muthén, 2017). In this study, classrooms were viewed as clusters, and schools as strata.

The SEM analyses consist of the evaluation of the overall model fit and parameter estimates (Kline, 2016). The overall fit indices include Chi-square Test, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA) (Kline, 2016). MLR gives Satorra-Bentler adjusted Chi-square Test and the model shows goodness-of-fit when test statistics fail to reject the null hypothesis at specific α level. CFI represents the improved fit over an independence model. A CFI larger than .95 indicates a good fit. A related fit index is TLI, and a good fit is indicated when TLI is larger than .95. SRMR and RMSEA assess badness-of-fit, with 0 indicating the best model fit. A model with SRMR less than .08 and RMSEA less than .06 is considered a good fit.

The principle of parsimony was adopted to select the final models, that is to say, the simpler model was preferred when both models fitted the data well and were theoretically

reasonable (Kline, 2016). Nonsignificant paths were dropped one at a time from the saturated model in which every exogenous variable at pretest predicts every endogenous variable at posttest, until all the non-significant paths (i.e., $p > .1$) were dropped unless they were needed to compute indirect effects. Satorra-Bentler Scaled Chi-square Difference Test was applied to compare the nested model against the null model and test whether it was worth the modification. Other indications of good fit include high R_2 and small standardized and normalized residuals. All of these fit statistics were considered to evaluate the goodness-of-fit of the hypothesized models in the study.

3.2.3 Hypothesized Models

Exogenous variables in the mediation and moderation models included experimental condition (i.e., the ITSS group coded as 1 and the control group as 0), gender (i.e., female coded as 1 and male as 0), structure strategy self-efficacy at pretest (SSEFPR), reading self-efficacy at pretest (RDEFPR), learning self-efficacy at pretest (LNEFPR), and reading comprehension at pretest (GSRTPR). Endogenous variables were structure strategy self-efficacy at posttest (SSEFPO), reading self-efficacy at posttest (RDEFPO), learning self-efficacy at posttest (LNEFPO), and GSRT scores at posttest (GSRTPO).

Hypothesized models are presented to address each of the four research questions. They are recursive models because there is no direct effect among endogenous variables (i.e., satisfying the null-B rule) when errors are correlated (Kline, 2016). Hypothesized model 1 is displayed in Figure 3. 7 to test the first hypothesis (i.e., reading comprehension mediates the effect of ITSS instruction on structure strategy self-efficacy, reading self-efficacy, and learning self-efficacy). The indirect effects of ITSS instruction on self-efficacy ratings are the cross-product of a and b_1,

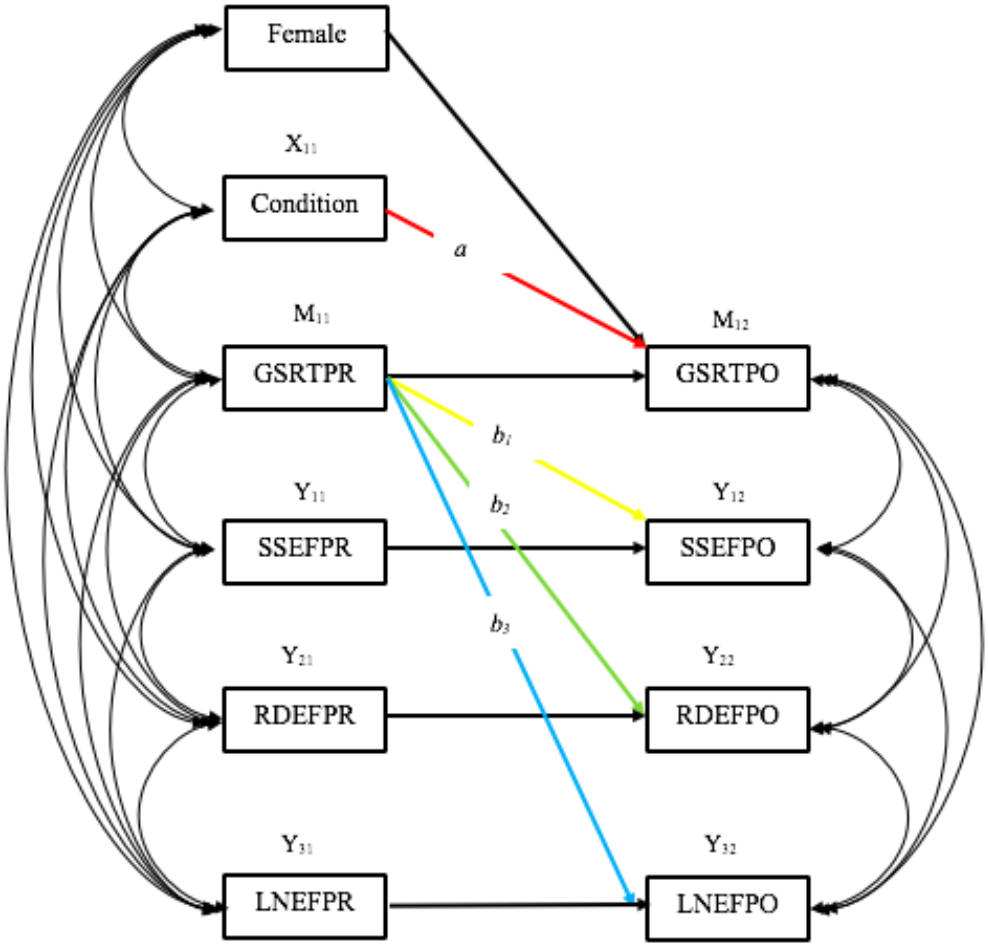
a and b_2, *a* and b_3. If the indirect effect is statistically significant, the hypothesis of mediation is supported and vice versa.

Hypothesized model 2 shown in Figure 3. 8 is generated to test the second hypothesis (i.e., prior reading comprehension moderates the effect of ITSS instruction on structure strategy self-efficacy, reading self-efficacy, and learning self-efficacy). Moderation analysis is conducted to evaluate the consistency of instructional impact on self-efficacy across different levels of prior reading comprehension. If the interaction between condition and prior reading comprehension (i.e., Con x GSRTPR) is statistically significant, the hypothesis of moderation is supported. Gender and prior self-efficacy ratings are included as covariates. Follow-up tests are also conducted to examine the instructional impact for children scoring lower than average (i.e., one standard deviation below the mean), at the average (i.e., at the mean), and higher than average (i.e., one standard deviation above the mean) on GSRT at pretest.

Hypothesized model 3, as illustrated in Figure 3. 9, examines the mediating effect of self-efficacy for the instructional impact on reading comprehension. The indirect effects are represented as the cross-products of a_1 and b_1, a_2 and b_2, a_3 and b_3. If the a_1 b_1 is found statistically significant, for example, the hypothesis that ITSS influences students' reading comprehension through the growth of structure strategy self-efficacy is supported.

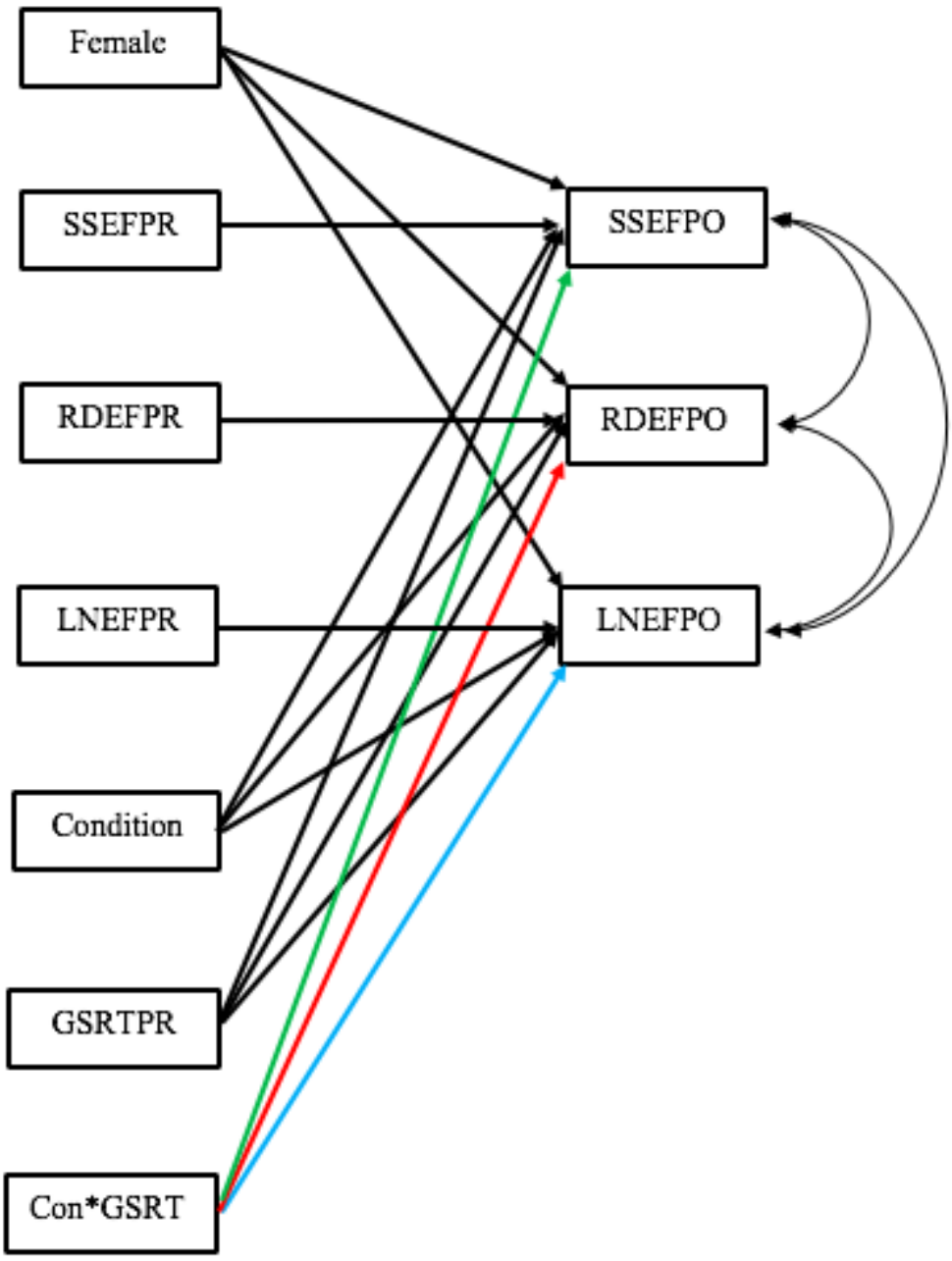
Hypothesized model 4 explores the interaction between condition and initial self-efficacy ratings on reading comprehension. They are indicated in Figure 3. 10 as X_1Z_1, X_2Z_2, and X_3Z_3. For example, if the effect of X_1Z_1 on Y_2 is statistically significant, the hypothesis that structure strategy self-efficacy moderates the instructional impact on reading comprehension is supported. Similarly, follow-up tests are conducted to find out the effect of ITSS on reading comprehension for children scoring high, middle, and low on structure strategy self-efficacy at pretest.

Figure 3. 6 Hypothesized Model 1: The Mediating Effect of Reading Comprehension



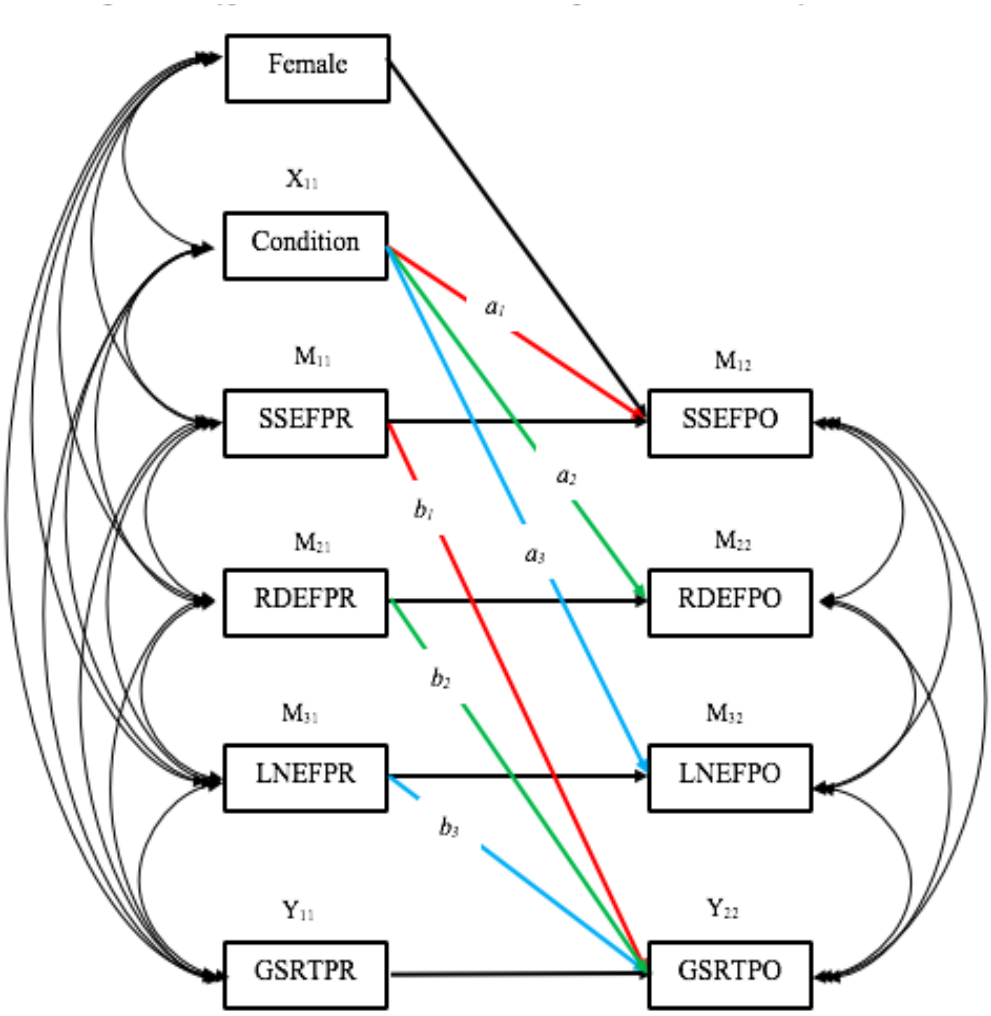
Note. Female = 1, Male = 0. Condition = 0 (control group), Condition = 1 (ITSS group). SSEFPR = structure strategy self-efficacy pretest, RDEFPR = reading self-efficacy pretest, LNEFPR = learning self-efficacy pretest, GSRTPR = the Gray Silent Reading Test pretest, SSEFPO = structure strategy self-efficacy posttest, RDEFPO = reading self-efficacy posttest, LNEFPO = learning self-efficacy posttest, GSRTPO = the Gray Silent Reading Test posttest.

Figure 3. 7 Hypothesized Model 2: The Moderating Effect of Reading Comprehension



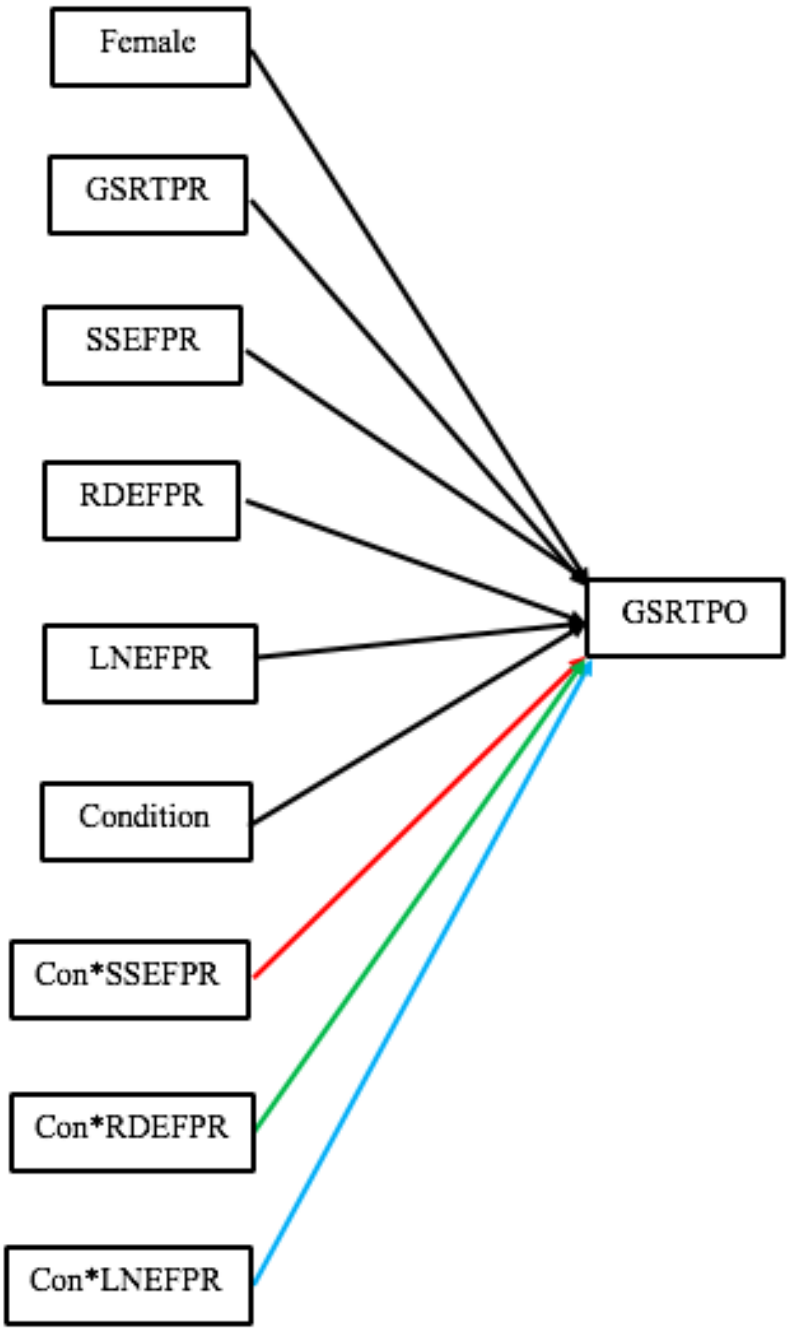
Note. Female = 1, Male = 0. Condition = 0 (control group), Condition = 1 (ITSS group). SSEFPR = structure strategy self-efficacy pretest, RDEFPR = reading self-efficacy pretest, LNEFPR = learning self-efficacy pretest, GSRTPR = the Gray Silent Reading Test pretest, SSEFPO = structure strategy self-efficacy posttest, RDEFPO = reading self-efficacy posttest, LNEFPO = learning self-efficacy posttest, GSRTPO = the Gray Silent Reading Test posttest.

Figure 3. 8 Hypothesized Model 3: The Mediating Effect of Self-efficacy



Note. Female = 1, Male = 0. Condition = 0 (control group), Condition = 1 (ITSS group). SSEFPR = structure strategy self-efficacy pretest, RDEFPR = reading self-efficacy pretest, LNEFPR = learning self-efficacy pretest, GSRTPR = the Gray Silent Reading Test pretest, SSEFPO = structure strategy self-efficacy posttest, RDEFPO = reading self-efficacy posttest, LNEFPO = learning self-efficacy posttest, GSRTPO = the Gray Silent Reading Test posttest.

Figure 3. 9 Hypothesized Model 4: The Moderating Effect of Self-efficacy



Note. Female = 1, Male = 0. Condition = 0 (control group), Condition = 1 (ITSS group). SSEFPR = structure strategy self-efficacy pretest, RDEFPR = reading self-efficacy pretest, LNEFPR = learning self-efficacy pretest, GSRTPR = the Gray Silent Reading Test pretest, SSEFPO = structure strategy self-efficacy posttest, RDEFPO = reading self-efficacy posttest, LNEFPO = learning self-efficacy posttest, GSRTPO = the Gray Silent Reading Test posttest.

Chapter 4

Results

The results of the SEM analyses are displayed in correspondence with the four hypothesized models. The first section presents descriptive statistics of reading comprehension scores and ratings on structure strategy self-efficacy, reading self-efficacy, and learning self-efficacy at pretest and posttest. The following two sections exhibit the results of mediation and moderation analyses, which include the overall model evaluation, parameter estimates, and interpretations.

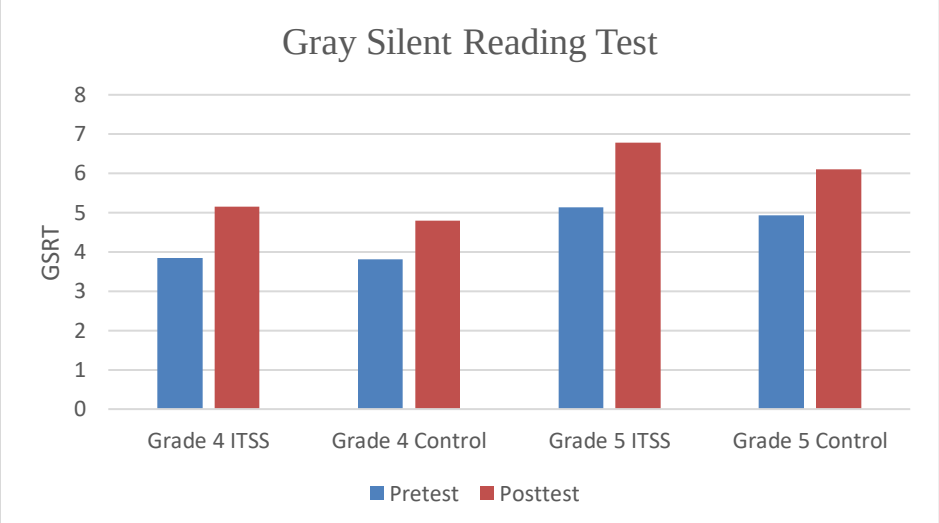
4.1 Descriptive Statistics

Sample means and standard deviations of GSRT scores at pretest and posttest are presented in Table 4. 1 and Figure 4. 1. GSRT provided grade equivalent scores that represent students' reading comprehension performance in reference to their cohorts at school. It showed that fourth-grade classrooms delivered with ITSS instruction scored approximately equivalent to those in the control group on GSRT pretest (i.e., 3.85 vs. 3.81), and both groups scored slightly lower than 4.0, the median score of students entering Grade 4. After the ITSS lessons were delivered, the ITSS classrooms scored higher than the control classrooms on GSRT posttest (i.e., 5.15 vs. 4.80). Fifth-grade ITSS classrooms scored .2 point higher than the control classrooms on GSRT pretest (i.e., 5.14 vs. 4.94) and also showed greater gains in reading comprehension at the end of the academic year (i.e., 6.78 vs. 6.10).

Table 4. 1 Descriptive Statistics of GSRT Scores by Condition, Grade, and Time

	Experimental Condition					
	ITSS			Control		
	n	M	SD	n	M	SD
Grade 4						
Class level						
Pretest	65	3.85	.87	65	3.81	.81
Posttest	64	5.15	1.10	66	4.80	.98
Student level						
Pretest	1406	3.85	2.48	1342	3.84	2.45
Posttest	1289	5.11	3.17	1354	4.80	3.05
Grade 5						
Class level						
Pretest	65	5.14	1.07	63	4.94	1.03
Posttest	65	6.78	.97	62	6.10	1.01
Student level						
Pretest	1351	5.19	3.03	1294	5.00	2.97
Posttest	1258	6.77	3.26	1227	6.16	3.37

Figure 4. 1 Classroom-level Means of GSRT Scores by Condition, Grade and Time



The classroom-level and student-level descriptive statistics of self-efficacy ratings are shown respectively in Table 4. 2 and Figure 4.2 for Grade 4, and in Table 4. 3 and Figure 4.3 for Grade 5. No significant group difference was found on prior structure strategy self-efficacy, reading self-efficacy, or learning self-efficacy. Students regardless of condition and grade tended

to rate themselves higher on reading self-efficacy and learning self-efficacy than structure strategy self-efficacy at pretest and posttest. Moreover, fifth graders appeared to be more confident in fulfilling all the academic demands than fourth graders. The results were expected because learners tended to improve self-efficacy beliefs or develop more accurate self-efficacy judgments when they had more experience and accumulated more knowledge in a domain. Chronologically, students were found to increase their ratings of structure strategy self-efficacy and reading self-efficacy from pretest to posttest, whereas their beliefs in learning persistence were essentially the same or slightly decreased from pretest to posttest. The results also met our expectations because structure strategy self-efficacy and reading self-efficacy should be more likely to be affected by ITSS instruction than learning self-efficacy.

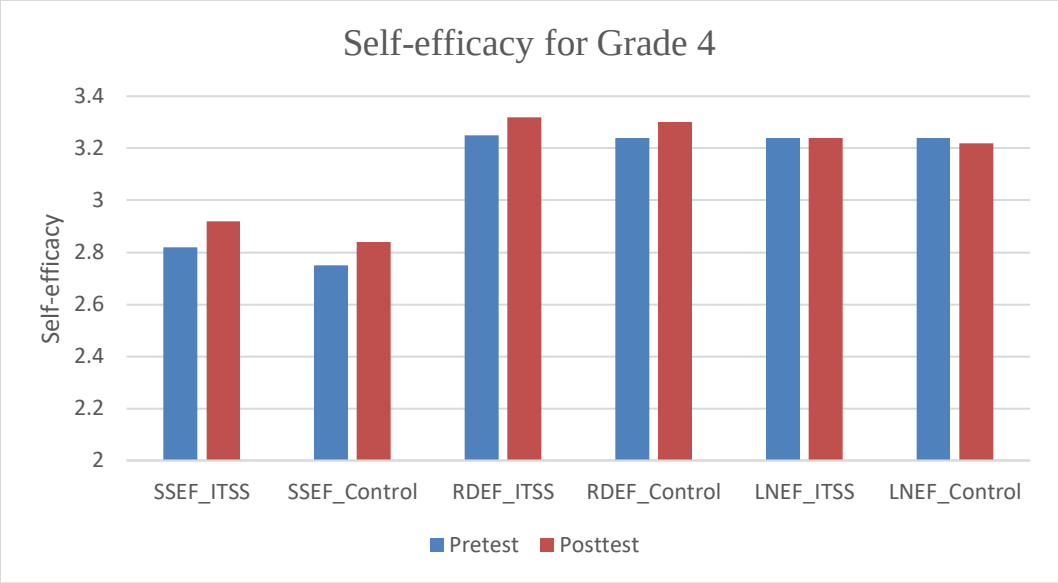
Table 4. 2 Descriptive Statistics of Self-efficacy by Condition and Time for Grade 4

	Experimental Condition					
	ITSS			Control		
	n	M	SD	n	M	SD
	Structure Strategy Self-efficacy					
Class level						
Pretest	56	2.82	.32	59	2.75	.28
Posttest	59	2.92	.18	60	2.84	.25
Student level						
Pretest	958	2.79	.70	1037	2.76	.73
Posttest	1124	2.91	.67	1102	2.86	.69
	Reading Self-efficacy					
Class level						
Pretest	59	3.25	.23	60	3.24	.20
Posttest	59	3.32	.12	60	3.30	.14
Student level						
Pretest	1059	3.26	.56	1121	3.26	.66
Posttest	1163	3.32	.50	1154	3.31	.51
	Learning Self-efficacy					
Class level						
Pretest	58	3.24	.28	60	3.24	.21
Posttest	59	3.24	.15	60	3.22	.17
Student level						
Pretest	1013	3.28	.64	1094	3.26	.66
Posttest	1154	3.24	.54	1150	3.22	.56

Table 4. 3 Descriptive Statistics of Self-efficacy by Condition and Time for Grade 5

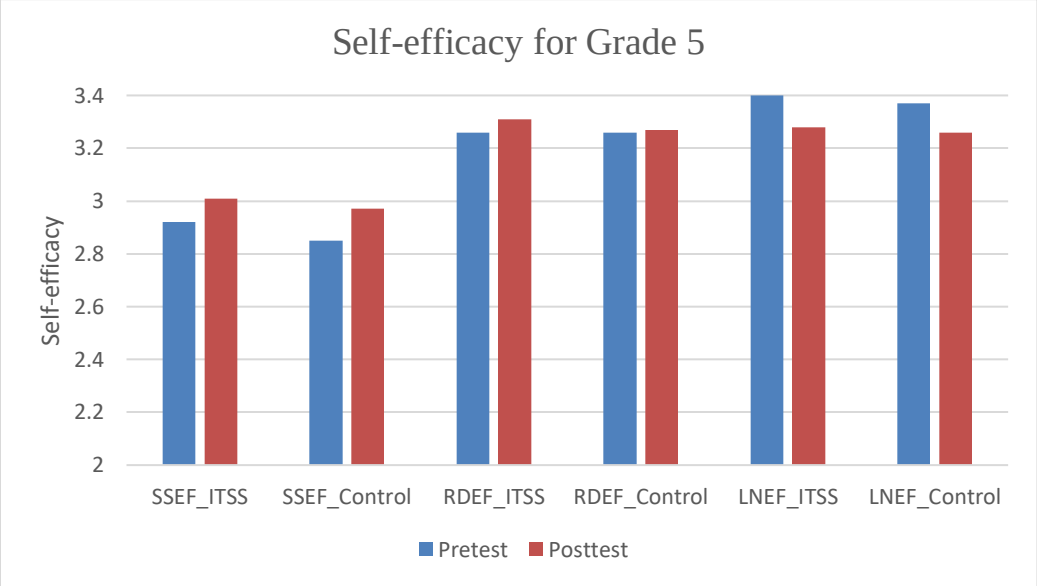
	Experimental Condition					
	ITSS			Control		
	n	M	SD	n	M	SD
	Structure Strategy Self-efficacy					
Class level						
Pretest	56	2.92	.19	57	2.85	.22
Posttest	59	3.01	.18	56	2.97	.23
Student level						
Pretest	1114	2.92	.66	1048	2.89	.67
Posttest	1191	3.02	.66	1054	2.99	.69
	Reading Self-efficacy					
Class level						
Pretest	57	3.27	.12	57	3.26	.21
Posttest	59	3.31	.12	56	3.27	.17
Student level						
Pretest	1158	3.26	.50	1105	3.27	.52
Posttest	1214	3.31	.50	1087	3.28	.53
	Learning Self-efficacy					
Class level						
Pretest	57	3.40	.14	57	3.37	.19
Posttest	59	3.28	.12	56	3.26	.15
Student level						
Pretest	1146	3.40	.50	1087	3.38	.52
Posttest	1214	3.28	.50	1081	3.27	.51

Figure 4. 2 Classroom-level Means of Self-efficacy by Condition and Time for Grade 4



Note. SSEF_ITSS = structure strategy self-efficacy in ITSS instruction group; SSEF_Control = structure strategy self-efficacy in control group; RDEF_ITSS = reading self-efficacy in ITSS instruction group; RDEF_Control = reading self-efficacy in control group; LNEF_ITSS = learning self-efficacy in ITSS instruction group; LNEF_Control = learning self-efficacy in control group.

Figure 4. 3 Classroom-level Means of Self-efficacy by Condition and Time for Grade 5



Note. SSEF_ITSS = structure strategy self-efficacy in ITSS instruction group; SSEF_Control = structure strategy self-efficacy in control group; RDEF_ITSS = reading self-efficacy in ITSS instruction group; RDEF_Control = reading self-efficacy in control group; LNEF_ITSS = learning self-efficacy in ITSS instruction group; LNEF_Control = learning self-efficacy in control group.

4.2 The Effect of ITSS Instruction on Self-efficacy

This section examines the mediating and moderating effects of reading comprehension for the relation between ITSS instruction and self-efficacy beliefs using the half-longitudinal mediation and moderation models. The mediation and moderation analyses begin with the overall model evaluation, followed by the estimation of parameters in the final model, and brief interpretations of the results are given at the end.

4.2.1 Mediation Analysis of Reading Comprehension

This study used a theoretically driven model-trimming strategy that consists of dropping one path at a time and evaluating changes in fit across models (Kline, 2016). Specifically, the initial model was obtained in which every exogenous variable had a direct effect on every endogenous variable. The alternative models were obtained through dropping insignificant paths unless the path was needed to compute indirect effects and, in that case, it would be retained. Each model was compared with the previous one using the Satorra-Bentler Scaled Chi-square Difference Test and other fit indicators, as shown in Table 4. 4. The goal of model comparison was to look for a final model that not only fitted the data well but also parsimony and interpretable. To address the first hypothesis, we examined the mediating effect of reading comprehension for the relation between ITSS instruction and self-efficacy in structure strategy, reading, and learning, controlling for gender, prior reading comprehension and self-efficacy.

Table 4. 4 Model Comparisons for the Mediation Analysis of Reading Comprehension

Grade	Model	χ^2	*df*	*p*	Scaling Correction Factor for MLR	*S-B* χ^2	Δ *df*	CFI/ TLI	SRMR	RMSEA
Grade 4	1 = Saturated Model	0	0	0	1.000	/	/	1.000/ 1.000	.000	.000
	2 = Drop LNEFPR → RDEFPO	.790	1	.3741	1.1388	.790	1	1.000/ 1.002	.002	.000
	3 = Drop SSEFPR → GSRTPO	2.803	2	.2462	1.0114	2.190	1	1.000/ .996	.004	.011
	4 = Drop SSEFPR → LNEFPO.	4.388	3	.2225	1.0408	1.575	1	1.000/ .995	.006	.012
Grade 5	1 = Saturated Model	0	0	0	1.000	/	/	1.000/ 1.000	.000	.000
	2 = Drop SSEFPR → LDEFPO	.898	1	.3434	.9927	.898	1	1.000/ 1.001	.002	.000
	3 = Drop SSEFPR → GSRTPO	3.249	2	.1970	1.1464	2.180	1	1.000/ .995	.004	.014

Results indicated that Model 2 through Model 4 fitted Grade 4 data well. Model 2 was generated by removing one insignificant path (i.e., LNEFPR → RDEFPO) from the saturated model. Goodness-of-fit was shown as $\chi^2(1) = .790$, $p = .3741$; RMSEA = .000 with 90% *CI* = [.000, .045]; CFI = 1.000, TLI = 1.002; SRMR = .002. Model 3 was obtained by dropping the second path (i.e., SSEFPR → GSRTPO). Goodness-of-fit was shown as $\chi^2(2) = 2.803$, $p = .2462$; RMSEA = .011 with 90% *CI* = [.000, .039]; CFI = 1.000, TLI = .996; SRMR = .004. Similarly, Model 4 was obtained by removing the third path (i.e., SSEFPR → LNEFPO), which provided good fit: $\chi^2(3) = 4.388$, $p = .2225$; RMSEA = .012 with 90% *CI* = [.000, .035]; CFI = 1.000, TLI = .995; SRMR = .006. Results of Satorra-Bentler Test showed that Model 2 fitted the data no worse than Model 1 (Satorra-Bentler $\chi^2 = .79$, $df = 1$, $p > .05$). Similarly, Model 3 fitted the data no worse than Model 2 (Satorra-Bentler $\chi^2 = 2.19$, $df = 1$, $p > .05$). Model 4 was chosen as the final model, because it fitted the data equally well as Model 3 (Satorra-Bentler $\chi^2 = 1.575$, $df = 1$, $p > .05$) and was the most parsimonious. The model trimming was ended because all of the irrelevant and insignificant paths were dropped out of the model.

For Grade 5, Model 2 and Model 3 both fitted the data well. Model 2 was generated by removing one insignificant path (i.e., SSEFPR → LDEFPO) from Model 1, and model 3 dropped another path (i.e., SSEFPR → GSRTPO). It is noted that, even though ITSS instruction did not have significant, direct effect on self-efficacy, and gender did not have significant, direct effect on any of the outcomes, these paths were retained for interpretative purposes. Fit indices for Model 2 were indicated as $\chi^2(1) = .898$, $p = .3434$; RMSEA = .000 with 90% *CI* = [.000, .047]; CFI = 1.000, TLI = 1.001; SRMR = .002. Chi-square Test suggested Model 2 well fitted Grade 5 data because it failed to reject the null hypothesis at .05 level. RMSEA, CFI, TLI and SRMR also showed good model fit. Goodness-of-fit of Model 3 was indicated as $\chi^2(2) = 3.249$, $p = .1970$; RMSEA = .014 with 90% *CI* = [.000, .041]; CFI = 1.000, TLI = .995; SRMR = .004. Satorra-Bentler Test suggested that Model 2 fitted the data no worse than Model 1 (Satorra-Bentler $\chi^2 = .898$, $df = 1$, $p > .05$). Similarly, Model 3 fitted the data no worse than Model 2 (Satorra-Bentler $\chi^2 = 2.18$, $df = 1$, $p > .05$). Therefore, Model 3 was selected as the final model due to parsimonies.

Parameter estimates of the direct and indirect effects are displayed in Table 4. 5 and Figure 4. 4. Results indicated that ITSS instruction did not have significant, direct effect on GSRT scores at posttest ($b = .235$, $SE = .145$, $p = .104$), controlling for gender and prior reading performance. Gender did not make significant difference on GSRT posttest. Prior GSRT scores had a significant, direct effect on structure strategy self-efficacy posttest ($b = .040$, $SE = .005$, $p < .001$), reading self-efficacy posttest ($b = .033$, $SE = .003$, $p < .001$), and learning self-efficacy posttest ($b = .024$, $SE = .004$, $p < .001$) controlling for the initial self-efficacy beliefs. The direct effects of ITSS instruction on self-efficacies were non-significant.

Standardized estimates were obtained using STDYX and STDY in M*plus*. STDYX is used to compute standardized estimates for continuous covariates and STDY used for binary covariates (Muthén & Muthén, 2017). Results indicated that fourth graders in the ITSS group got

.076 standard deviation unit higher on GSRT posttest than the control group, controlling for gender, prior reading and self-efficacies. In addition, with one standard deviation increase in GSRT scores at pretest, students were expected to increase by .147 standard deviation unit in structure strategy self-efficacy, .159 standard deviation unit in reading self-efficacy, and .107 standard deviation unit in learning self-efficacy, when prior self-efficacies and gender were held constant.

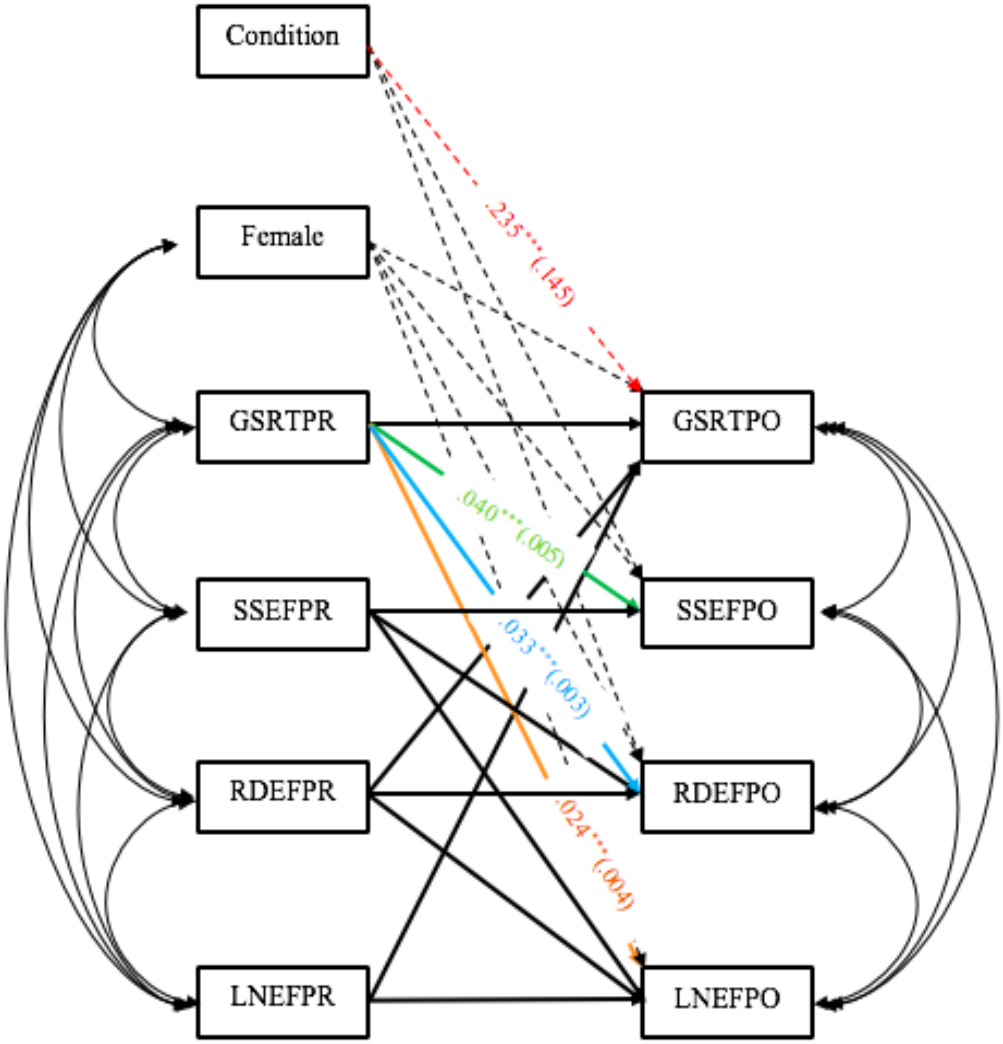
The indirect effects of ITSS instruction on self-efficacy via reading comprehension were computed by multiplying the estimates of two paths. The indirect effect of ITSS on structure strategy self-efficacy posttest is .009 (.235 for Condition → GSRTPO times .040 for GSRTPR → SSEFPO). That is, the ITSS group outperformed the control group by .009 points on structure strategy self-efficacy posttest through the growth of reading comprehension, after controlling for prior self-efficacy beliefs and gender. Standardized estimates of the indirect effects were computed by dividing the unstandardized estimates by the pooled standard deviation of the corresponding outcomes. The ITSS group scored .013 standard deviation units higher on structure strategy self-efficacy, .016 standard deviation units higher on reading self-efficacy, and .011 standard deviation units higher on learning self-efficacy via the growth of reading comprehension, compared with their counterparts in the control group. However, these indirect effects were not statistically significant at the .05 level, indicating that reading comprehension did not mediate the impact of ITSS on any of the self-efficacy outcomes.

Table 4. 5 Mediation Analysis of Reading Comprehension (Grade 4)

Path	Unstandardized Coefficient *b*	Standardized Coefficient *β*	Standard Errors for *b*	95% *CI* for *b*
		Direct Effect		
ITSS → GSRTPO	.235	.076	.145	[-.048, .519]
ITSS → SSEFPO	.032	.047	.031	[-.028, .093]
ITSS → RDEFPO	-.005	-.010	.015	[-.036, .025]
ITSS → LNEFPO	.007	.013	.025	[-.043, .056]
GSRTPR → SSEFPO	.040***	.147***	.005	[.030, .050]
GSRTPR → RDEFPO	.033***	.159***	.003	[.026, .039]
GSRTPR → LNEFPO	.024***	.107***	.004	[.015, .032]
		Indirect Effect		
ITSS → GSRT → SSEFPO	.009	.013	.006	[-.003, .020]
ITSS → GSRT →RDEFPO	.008	.016	.005	[-.002, .016]
ITSS → GSRT →LNEFPO	.006	.011	.004	[-.001, .013]

Note. This table presents unstandardized estimates, standardized estimates, standard errors, and 95% *CI* for unstandardized estimates for the mediation analysis of reading comprehension. ITSS = Intelligent Tutoring of Structure Strategy; GSRTPR = The Gray Silent Reading Test pretest; GSRTPO = The Gray Silent Reading Test posttest; SSEFPO = structure strategy self-efficacy posttest; RDEFPO = reading self-efficacy posttest; LNEFPO = learning self-efficacy posttest. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 4. 4 Mediation Analysis of Reading Comprehension (Grade 4)



Note. This figure presents unstandardized estimates (standard errors) for the mediation analysis of reading comprehension. GSRTPR = The Gray Silent Reading Test pretest; SSEFPR = structure strategy self-efficacy pretest; RDEFPR = reading self-efficacy pretest; LNEFPR = learning self-efficacy pretest; GSRTPO = The Gray Silent Reading Test posttest; SSEFPO = structure strategy self-efficacy posttest; RDEFPO = reading self-efficacy posttest; LNEFPO = learning self-efficacy posttest. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Parameter estimates and standard errors for fifth-grade students are presented in Table 4. 6 and Figure 4. 5. The results indicated that ITSS instruction had significant, direct effects on GSRT posttest (b = .398, SE = .155, p <.05). Fifth graders in the ITSS group scored .398 points higher on reading comprehension posttest than the control group, after controlling for prior reading comprehension and gender. The direct effects of ITSS instruction were non-significant on self-efficacies. Moreover, GSRT pretest had significant, direct effects on structure strategy self-efficacy posttest (b = .033, SE = .005, p < .001), reading self-efficacy posttest (b = .029, SE = .003, p < .001), and learning self-efficacy posttest (b = .013, SE = .004, p < .01) when prior self-efficacy levels and gender were held constant.

Standardized path coefficients are also presented, indicating that the ITSS group got .12 standard deviation units higher on GSRT posttest than the control group after controlling for pretest and gender (β = .120, SE = .023, p < .05). Meanwhile, with one standard deviation unit of increase in GSRT pretest scores, students were expected to get .148 standard deviation units higher on structure strategy self-efficacy posttest (β = .148, SE = .020, p < .001), .166 standard deviation units higher on reading self-efficacy posttest (β = .166, SE = .017, p < .001), and .078 standard deviation units higher on learning self-efficacy posttest (β = .078, SE = .024, p < .01) when prior self-efficacies and gender were held constant.

Reading comprehension was found to be a significant mediator for the impact of ITSS instruction on structure strategy self-efficacy (b = .013, β = .019, SE = .005, p < .05) and reading self-efficacy (b = .011, β = .021, SE = .005, p < .05). Notably, the indirect effect of ITSS on learning self-efficacy was marginally significant (b = .005, β = .001, SE = .003, p = .067, 95% CI = [.001, .012]). Fifth graders in the ITSS group scored .013 points higher on structure strategy self-efficacy posttest, .011 points higher on reading self-efficacy posttest, and .005 points higher

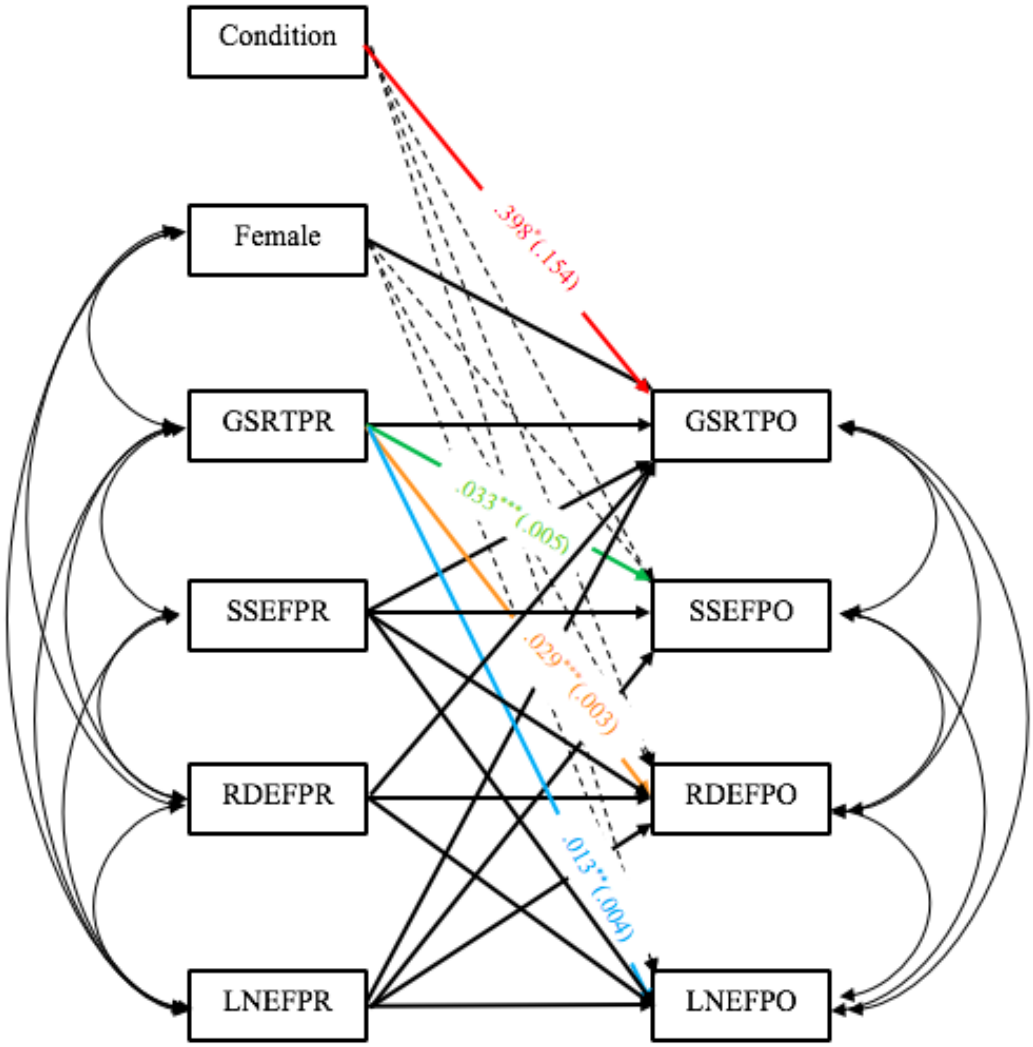
on learning self-efficacy posttest through the growth of reading comprehension than the control group, after controlling for gender and prior self-efficacy beliefs.

Table 4. 6 Mediation Analysis of Reading Comprehension (Grade 5)

Path	Unstandardized Coefficient *b*	Standardized Coefficient *β*	Standard Errors for *b*	95% *CI* for *b*
	Direct Effect			
ITSS → GSRTPO	.398*	.120*	.154	[.096, .701]
ITSS → SSEFPO	.019	.028	.033	[-.044, .083]
ITSS → RDEFPO	.030	.058	.021	[-.010, .071]
ITSS → LNEFPO	-.001	.002	.021	[-.042, .040]
GSRTPR → SSEFPO	.033***	.148***	.005	[.024, .042]
GSRTPR → RDEFPO	.029***	.166***	.003	[.023, .034]
GSRTPR → LNEFPO	.013**	.078**	.004	[.005, .021]
	Indirect Effect			
ITSS → GSRT → SSEFPO	.013*	.019*	.005	[.003, .024]
ITSS → GSRT →RDEFPO	.011*	.021*	.005	[.002, .021]
ITSS → GSRT →LNEFPO	.005+	.001+	.003	[.001, .012]

Note. This table presents unstandardized estimates, standardized estimates, standard errors, and 95% CI for unstandardized estimates for the mediation analysis of reading comprehension. ITSS = Intelligent Tutoring of Structure Strategy; GSRTPR = The Gray Silent Reading Test pretest; GSRTPO = The Gray Silent Reading Test posttest; SSEFPO = structure strategy self-efficacy posttest; RDEFPO = reading self-efficacy posttest; LNEFPO = learning self-efficacy posttest. + $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 4. 5 Mediation Analysis of Reading Comprehension (Grade 5)



Note. This figure presents unstandardized estimates (standard errors) for the mediation analysis of reading comprehension. GSRTPR = The Gray Silent Reading Test pretest; SSEFPR = structure strategy self-efficacy pretest; RDEFPR = reading self-efficacy pretest; LNEFPR = learning self-efficacy pretest; GSRTPO = The Gray Silent Reading Test posttest; SSEFPO = structure strategy self-efficacy posttest; RDEFPO = reading self-efficacy posttest; LNEFPO = learning self-efficacy posttest. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

4.2.2 Moderation Analysis of Reading Comprehension

Moderation analysis was conducted to examine the consistency of instructional impact on fourth and fifth graders' self-efficacy in structure strategy, reading and learning. Specifically, our goal was to examine the interaction between experimental condition and prior reading comprehension on the outcomes of self-efficacy. Gender and prior level of self-efficacy were included as covariates to explain the variance in the outcomes.

Model comparisons are illustrated in Table 4. 7. Model 1 was the saturated model and Model 3 was generated by dropping two insignificant paths from Model 1 (i.e., LNEFPR → RDEFPO, SSEFPR → LNEFPO). *S-B* Difference Test indicated that Model 2 fitted the data no worse than Model 1 (Satorra-Bentler $\chi_2 = .979$, $df = 1$, $p > .05$), and Model 3 fitted the data no worse than Model 2 (Satorra-Bentler $\chi_2 = 1.919$, $df = 1$, $p > .05$). The overall fit of Model 3 was considerably good ($\chi_2 (2) = 2.890$, $p = .2357$; RMSEA = .012 with 90% *CI* = [.000, .039]; CFI = 1.000, TLI = .995; SRMR = .005). Similarly, for Grade 5 students, Model 2 was obtained by dropping one non-significant path (i.e., SSEFPR → LNEFPO) and showed goodness-of-fit as $\chi_2 (1) = .971$, $p = .3244$; RMSEA = .000 with 90% *CI* = [.000, .047]; CFI = 1.000, TLI = 1.000; SRMR = .002. *S-B* Difference Test suggested that Model 2 fitted no worse than the previous one (Satorra-Bentler $\chi_2 = .971$, $df = 1$, $p > .05$). Parameter estimates and standard errors were obtained using the final model.

Table 4. 7 Model Comparisons for the Moderation Analysis of Reading Comprehension

Grade	Model	MLR χ^2	*df*	*p*	Scaling Correction Factor for MLR	S-B χ^2	Δ *df*	CFI/ TLI	SRMR	RMSEA
Grade 4	1 = Saturated Model	0	0	0	1.000	/	/	1.000/ 1.000	.000	.000
	2 = Drop LNEFPR → RDEFPO	.979	1	.3224	1.1240	.979	1	1.000/ 1.000	.003	.000
	3 = Drop SSEFPR → LNEFPO	2.890	2	.2357	1.1147	1.919	1	1.000/ .995	.005	.012
Grade 5	1 = Saturated Model	0	0	0	1.000	/	/	1.000/ 1.000	.000	.000
	2 = Drop SSEFPR → LNEFPO	.971	1	.3244	.9815	.971	1	1.000/ 1.000	002	.000

Prior reading performance was grand mean centered for the convenience of interpretation. The results in Table 4. 8 showed that there was no statistically significant interaction between experimental condition and prior reading comprehension on structure strategy self-efficacy, reading self-efficacy, or learning self-efficacy, after controlling gender and prior self-efficacy levels. That is, the instructional impacts on self-efficacies were universal for fourth graders regardless of their prior performances in reading comprehension. ITSS instruction did not appear to have a significant effect on the self-efficacies after controlling for prior self-efficacy levels.

The results for fifth-grade students, shown in Table 4. 9, were different from fourth grade. Prior reading comprehension was found to be a significant moderator for the instructional impact on reading self-efficacy posttest (b = -.012, SE = .006, $p < .05$). The negative sign of the interaction suggested that ITSS was likely to provide higher benefits to fifth-grade under-achievers in reading comprehension, by improving their reading self-efficacy to a larger extent. However, the interaction between ITSS instruction and prior reading comprehension was non-significant on structure strategy self-efficacy or learning self-efficacy.

Table 4. 8 Moderation Analysis of Reading Comprehension (Grade 4)

Predictor	SSEFPO			
	b (SE)	95% *CI* for *b*	*β (SE)*	95% *CI* for *β*
Gender	.024 (.025)	[-.027, .075]	.018 (.019)	[-.020, .055]
SSEFPR	.293*** (.018)	[.257, .330]	.309*** (.018)	[.274, .345]
RDEFPR	.184*** (.039)	[.108, .259]	.148*** (.031)	[.088, .209]
LNEFPR	.079** (.026)	[.027, .131]	.076** (.026)	[.026, .126]
ITSS	.033 (.031)	[-.027, .094]	.025 (.023)	[-.020, .069]
GSRTPR	.046*** (.007)	[.033, .059]	.167*** (.024)	[.119, .215]
ITSS * GSRTPR	-.011 (.009)	[-.029, .006]	-.029 (.023)	[-.075, .017]
	RDEFPO			
	b (SE)	95% *CI* for *b*	*β (SE)*	95% *CI* for *β*
Gender	-.015 (.018)	[-.051, .021]	-.015 (.017)	[-.050, .021]
SSEFPR	.059*** (.016)	[.027, .091]	.083*** (.023)	[.038, .128]
RDEFPR	.434*** (.025)	[.384, .484]	.469*** (.026)	[.419, .519]
ITSS	-.004 (.015)	[-.034, .026]	-.004 (.014)	[-.034, .026]
GSRTPR	.037*** (.005)	[.027, .047]	.182*** (.024)	[.135, .228]
ITSS * GSRTPR	-.009 (.007)	[-.023, .004]	-.033 (.024)	[-.078, .013]
	LNEFPO			
	b (SE)	95% *CI* for *b*	*β (SE)*	95% *CI* for *β*
Gender	.015 (.022)	[-.029, .058]	-.014 (.020)	[-.028, .056]
RDEFPR	.190*** (.028)	[.135, .245]	.191*** (.028)	[.135, .246]
LNEFPR	.229*** (.026)	[.177, .281]	.273*** (.032)	[.211, .335]
Condition	.008 (.025)	[-.040, .056]	.007 (.023)	[-.038, .052]
GSRTPR	.026*** (.007)	[.014, .041]	.117*** (.030)	[.061, .172]
Condition * GSRTPR	-.006 (.009)	[-.023, .010]	-.019 (.031)	[-.077, .039]

Note. This table presents unstandardized estimates (standard errors) and standardized estimates (standard errors) and 95% CI for unstandardized estimates for the moderation analysis of reading comprehension. ITSS = Intelligent Tutoring of Structure Strategy; GSRTPR = The Gray Silent Reading Test pretest; SSEFPR = structure strategy self-efficacy pretest; RDEFPR = reading self-efficacy pretest; LNEFPR = learning self-efficacy pretest; GSRTPO = The Gray Silent Reading Test posttest; SSEFPO = structure strategy self-efficacy posttest; RDEFPO = reading self-efficacy posttest; LNEFPO = learning self-efficacy posttest. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4. 9 Moderation Analysis of Reading Comprehension (Grade 5)

Predictor	SSEFPO			
	b (SE)	95% *CI* for *b*	*β (SE)*	95% *CI* for *β*
Gender	.073** (.025)	[.024, .122]	.054** (.018)	[.018, .090]
SSEFPR	.316*** (.026)	[.266, .367]	.313*** (.025)	[.264, .362]
RDEFPR	.254*** (.042)	[.172, .336]	.192*** (.030)	[.132, .251]
LNEFPR	.090** (.030)	[.030, .149]	.068** (.029)	[.023, .113]
ITSS	.018 (.033)	[-.046, .082]	.013 (.024)	[-.034, .060]
GSRTPR	.038*** (.007)	[.025, .051]	.168*** (.029)	[.111, .225]
ITSS * GSRTPR	-.009 (.008)	[-.024, .007]	-.027 (.025)	[-.079, .024]
	RDEFPO			
	b (SE)	95% *CI* for *b*	*β (SE)*	95% *CI* for *β*
Gender	0.013 (.016)	[-.019, .045]	.012 (.016)	[-.019, .043]
SSEFPR	.061*** (.014)	[.033, .088]	.078*** (.018)	[.042, .114]
RDEFPR	.525*** (.028)	[.471, .579]	.515*** (.022)	[.471, .559]
LNEFPR	.071** (.022)	[.028, .113]	.070** (.022)	[.027, .113]
ITSS	.029 (.020)	[-.007, .074]	.028 (.019)	[-.010, .067]
GSRTPR	.035*** (.005)	[.026, .044]	.202*** (.029)	[.148, .257]
ITSS * GSRTPR	-.012* (.006)	[-.022, -.001]	-.048* (.024)	[-.095, -.002]
	LNEFPO			
	b (SE)	95% *CI* for *b*	*β (SE)*	95% *CI* for *β*
Gender	.017 (.018)	[-.018, .052]	.016 (.017)	[-.018, .051]
RDEFPR	.130*** (.032)	[.067, .193]	.131*** (.032)	[-.042, .039]
LNEFPR	.364*** (.032)	[.301, .427]	.368*** (.031)	[.067, .194]
ITSS	-.001 (.020)	[-.043, .040]	-.001 (.020)	[-.042, .039]
GSRTPR	.015** (.006)	[.004, .027]	.090*** (.034)	[.023, .158]
ITSS * GSRTPR	-.005 (.007)	[-.019, .010]	-.019 (.032)	[-.083, .044]

Note. This table presents unstandardized estimates (standard errors) and standardized estimates (standard errors) and 95% *CI* for unstandardized estimates for the moderation analysis of reading comprehension. ITSS = Intelligent Tutoring of Structure Strategy; GSRTPR = The Gray Silent Reading Test pretest; SSEFPR = structure strategy self-efficacy pretest; RDEFPR = reading self-efficacy pretest; LNEFPR = learning self-efficacy pretest; GSRTPO = The Gray Silent Reading Test posttest; SSEFPO = structure strategy self-efficacy posttest; RDEFPO = reading self-efficacy posttest; LNEFPO = learning self-efficacy posttest. * $p < .05$, ** $p < .01$, *** $p < .001$.

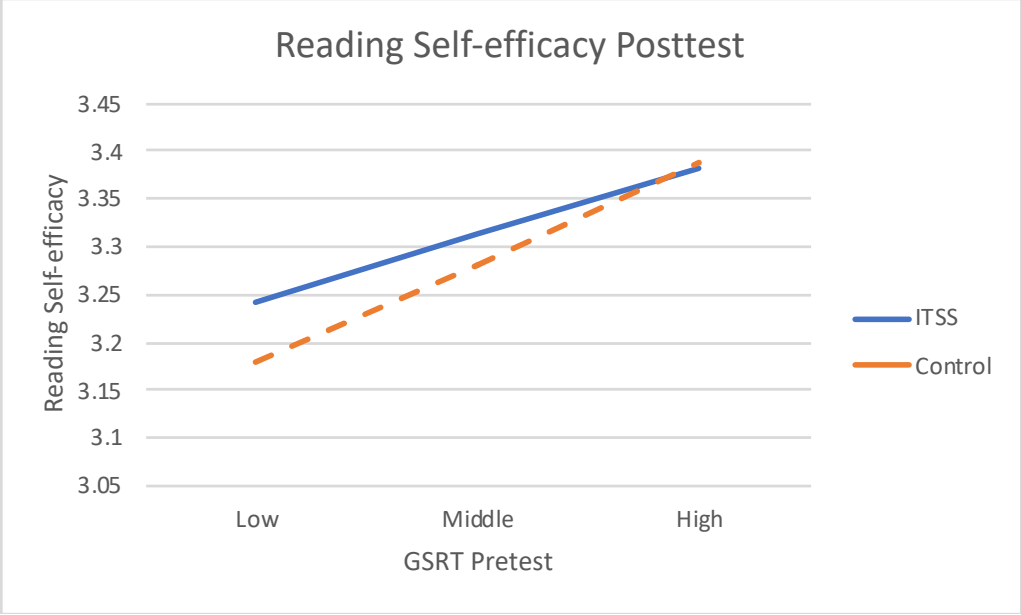
Follow-up tests were conducted to investigate the instructional impacts on reading self-efficacy for fifth-grade students scoring high, middle and low on prior reading comprehension. Table 4. 10 and Figure 4. 6 demonstrated that ITSS instruction exerted significant, positive impact on students' reading self-efficacy when they scored lower on GSRT pretest (b = .064, SE = .029, $p < .05$). For students who scored one standard deviation below the average, the ITSS group scored .064 points higher on reading self-efficacy than the control group. However, there was no significant group difference in reading self-efficacy when students performed better in prior reading comprehension.

Table 4. 10 Conditional Effects of ITSS Instruction on Reading Self-efficacy

Predictor = ITSS	Outcome = RDEFPO	
Moderator	*b (SE)*	95% *CI* for *b*
Low GSRTPR	.064* (.029)	[.008, .092]
Middle GSRTPR	.029 (.020)	[-.009, .072]
Higher GSRTPR	-.005 (.022)	[-.049, .040]

Note. This presents the unstandardized estimates, standard errors, and 95% *CI* for unstandardized estimates. ITSS = Intelligent Tutoring of Structure Strategy; GSRTPR = The Gray Silent Reading Test pretest; RDEFPO = reading self-efficacy posttest. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 4. 6 Conditional Effects of ITSS Instruction on Reading Self-efficacy



4.3 The Effect of ITSS Instruction on Reading Comprehension

This section examines the mediating and moderating effects of self-efficacy in structure strategy, reading, and learning on the relation between ITSS instruction and reading comprehension. It is hypothesized that ITSS instruction facilitates fourth and fifth graders' reading comprehension through improving their confidence in fulfilling specific academic tasks.

4.3.1 Mediation Analysis of Self-efficacy

Fit statistics and model comparisons for the mediation analysis of self-efficacy are presented in Table 4. 11. For students in Grade 4, Model 3 was selected as the final model due to the goodness-of-fit: χ_2 (2) = 2.716, p = .2571; RMSEA = .011 with 90% *CI* = [.000, .039]; CFI = 1.000, TLI = .995; SRMR = .004. Two insignificant paths were removed from the saturated model (i.e., LNEFPR → RDEFPO and SSEFPR → LNEFPO). *S-B* Difference Test showed that Model 2 fitted the data no worse than Model 1 (Satorra-Bentler χ_2 = .79, df = 1, p > .05). Similarly, Model 3 fitted the data no worse than Model 2 (Satorra-Bentler χ_2 = 1.95, df = 1, p > .05).

For students in Grade 5, Model 2 was generated by dropping one insignificant path from Model 1 (i.e., SSEFPR → LNEFPO). Model 2 showed good fit with χ_2 (1) = .898, p = .3434; RMSEA = .000 with 90% *CI* = [.000, .047]; CFI = 1.000, TLI = 1.001; SRMR = .002. Chi-square Difference Test indicated that Model 2 fitted the data no worse than Model 1 (Satorra-Bentler χ_2 = .898, df = 1, p > .05), therefore Model 2 was selected as the final model.

Table 4. 11 Model Comparisons for the Mediation Analysis of Self-efficacy

Grade	Model	MLR χ^2	*df*	*p*	Scaling Correction Factor for MLR	*S-B* χ^2	Δ *df*	CFI/ TLI	SRMR	RMSEA
Grade 4	1 = Saturated Model	0	0	0	1.000	/	/	1.000/ 1.000	.000	.000
	2 = Drop LNEFPR → RDEFPO	.790	1	.3741	1.1388	.790	1	1.000/ 1.002	.002	.000
	3 = Drop SSEFPR → LNEFPO	2.716	2	.2571	1.1116	1.95	1	1.000/ .996	.004	.011
Grade 5	1 = Saturated Model	0	0	0	1.000	/	/	1.000/ 1.000	.000	.000
	2 = Drop SSEFPR → LNEFPO	.898	1	.3434	.9927	.898	1	1.000/ 1.001	.002	.000

Parameter estimates for Grade 4 sample are shown in Table 4. 12. The results indicated that self-efficacy beliefs did not mediate the effect of ITSS instruction on fourth graders' reading comprehension. Meanwhile, initial structure strategy self-efficacy did not have significant, direct effect on reading comprehension, whereas reading self-efficacy (b = .875, β = .154, SE = .136, p < .001), and learning self-efficacy (b = .423, β = .088, SE = .090, p < .001) had significant, direct effects on reading comprehension, after controlling for gender and prior reading skill.

The results for Grade 5 sample are presented in Table 4. 13, which suggested that self-efficacy beliefs did not mediate the effect of ITSS instruction on reading comprehension either. Meanwhile, initial reading self-efficacy (b = 1.095, β = .167, SE = .153, p < .001) and learning self-efficacy (b = .546, β = .084, SE = .143, p < .001) were significant predictors of reading comprehension posttest, controlling for students' gender and prior reading skill. Notably, ITSS instruction had direct, significant effect on reading comprehension for fifth-grade students.

Table 4. 12 Mediation Analysis of Self-efficacy (Grade 4)

Path	Unstandardized Coefficient *b*	Standardized Coefficient *β*	Standard Errors for *b*	95% *CI* for *b*
	Direct Effect			
ITSS → SSEFPO	.032	.047	.031	[-.028, .093]
ITSS → RDEFPO	-.005	-.010	.014	[-.036, .025]
ITSS → LNEFPO	.007	.013	.025	[-.043, .056]
ITSS → GSRTPO	.231	.074	.146	[-.055, .516]
SSEFPR → GSRTPO	.122	.028	.092	[-.058, .303]
RDEFPR → GSRTPO	.875***	.154***	.136	[.608, 1.141]
LNEFPR → GSRTPO	.423***	.088***	.090	[.248, .599]
	Indirect Effect			
ITSS → SSEF → GSRTPO	.004	.001	.005	[-.005, .017]
ITSS → RDEF → GSRTPO	-.005	-.002	.013	[-.028, .025]
ITSS → LNEF → GSRTPO	.003	.001	.011	[-.015, .027]

Note. This table presents unstandardized estimates, standardized estimates, standard errors, and 95% *CI* for unstandardized estimates for the mediation analysis of self-efficacy. ITSS = Intelligent Tutoring of Structure Strategy; GSRTPR = The Gray Silent Reading Test pretest; SSEFPR = structure strategy self-efficacy pretest; RDEFPR = reading self-efficacy pretest; LNEFPR = learning self-efficacy pretest; GSRTPO = The Gray Silent Reading Test posttest; SSEFPO = structure strategy self-efficacy posttest; RDEFPO = reading self-efficacy posttest; LNEFPO = learning self-efficacy posttest. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4. 13 Mediation Analysis of Self-efficacy (Grade 5)

Path	Unstandardized Coefficient *b*	Standardized Coefficient *β*	Standard Errors for *b*	95% *CI* for *b*
	Direct Effect			
ITSS → SSEFPO	.019	.028	.033	[-.045, .083]
ITSS → RDEFPO	.030	.058	.021	[-.010, .071]
ITSS → LNEFPO	-.001	-.002	.021	[-.042, .040]
ITSS → GSRTPO	.395*	.119	.155	[.091, .699]
SSEFPR → GSRTPO	.193	.039	.130	[-.062, .449]
RDEFPR → GSRTPO	1.095***	.167***	.153	[.795, 1.395]
LNEFPR → GSRTPO	.546***	.084***	.143	[.266, .827]
	Indirect Effect			
ITSS → SSEF → GSRTPO	.004	.001	.009	[-.014, .022]
ITSS → RDEF → GSRTPO	.033	.010	.023	[-.008, .081]
ITSS → LNEF → GSRTPO	.000	.000	.011	[-.022, .022]

Note. This table presents unstandardized estimates, standardized estimates, standard errors, and 95% *CI* for unstandardized estimates for the mediation analysis of self-efficacy. ITSS = Intelligent Tutoring of Structure Strategy; GSRTPR = The Gray Silent Reading Test pretest; SSEFPR = structure strategy self-efficacy pretest; RDEFPR = reading self-efficacy pretest; LNEFPR = learning self-efficacy pretest; GSRTPO = The Gray Silent Reading Test posttest; SSEFPO = structure strategy self-efficacy posttest; RDEFPO = reading self-efficacy posttest; LNEFPO = learning self-efficacy posttest. * $p < .05$, ** $p < .01$, *** $p < .001$.

4.3.2 Moderation Analysis of Self-efficacy

Finally, we explored the moderating effects of structure strategy self-efficacy, reading self-efficacy, and learning self-efficacy for the instructional impact of ITSS on the outcome of reading comprehension. It was hypothesized that students would benefit differently from ITSS instruction when they held different levels of self-efficacy beliefs.

Results of the hypothesized models are shown in Table 4. 14 for Grade 4 and Table 4. 15 for Grade 5. In general, self-efficacy beliefs did not appear to moderate the instructional impact of ITSS on fourth and fifth graders' performances in reading comprehension, controlling for gender and prior reading skill. The non-significant interactions suggested that the effect of ITSS instruction appeared to be universal across all levels of self-efficacy in structure strategy, reading, and learning for both grades.

In summary, the results of mediation and moderation analyses indicated that first, reading comprehension may potentially mediate and moderate the effect of ITSS instruction on fifth-grade students' self-efficacy; second, self-efficacy did not mediate or moderate the effect of ITSS instruction on fourth and fifth graders' reading comprehension. Also, there were reciprocal relationships between reading performance and self-efficacy beliefs for fourth- and fifth-grade students (see Figure 4. 4 and 4. 5). The strength of the association was strongest between reading comprehension and reading self-efficacy, followed by structure strategy self-efficacy and learning self-efficacy. The results provided some evidence for the reciprocal relationship using the longitudinal design and supported our hypothesis about the strength of the association. Detailed discussions of the results are presented in the next chapter.

Table 4. 14 Moderation Analysis of Self-efficacy (Grade 4)

Predictor	GSRTPO			
	b (SE)	95% *CI* for *b*	*β (SE)*	95% *CI* for *β*
Gender	-.106 (.107)	[-.315, .103]	-.017 (.017)	[-.051, .017]
GSRTPR	.525*** (.027)	[.472, .578]	.414*** (.019)	[.377, .452]
ITSS	.260 (.145)	[-.025, .545]	.042 (.023)	[-.004, .087]
SSEFPR	.241* (.113)	[.018, .463]	.055* (.026)	[.004, .106]
ITSS * SSEFPR	-.253 (.165)	[-.577, .071]	-.040 (.026)	[-.090, .011]
RDEFPR	.892*** (.181)	[.538, 1.246]	.157*** (.032)	[.095, .219]
ITSS * RDEFPR	-.029 (.279)	[-.576, .518]	-.004 (.035)	[-.072, .065]
LNEFPR	.396** (.128)	[.144, .648]	.083** (.027)	[.030, .135]
ITSS * LNEFPR	.049 (.231)	[-.403, .501]	.007 (.033)	[-.058, .072]

Note. This table presents unstandardized estimates (standard errors) and standardized estimates (standard errors) and 95% *CI* for unstandardized estimates for the moderation analysis of self-efficacy. ITSS = Intelligent Tutoring of Structure Strategy; GSRTPR = The Gray Silent Reading Test pretest; SSEFPR = structure strategy self-efficacy pretest; RDEFPR = reading self-efficacy pretest; LNEFPO = learning self-efficacy posttest; GSRTPO = The Gray Silent Reading Test posttest. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4. 15 Moderation Analysis of Self-efficacy (Grade 5)

Predictor	GSRTPO			
	b (SE)	95% *CI* for *b*	*β (SE)*	95% *CI* for *β*
Gender	-.019 (.109)	[-.231, .194]	-.003 (.016)	[-.035, .029]
GSRTPR	.469*** (.023)	[.424, .514]	.423*** (.020)	[.385, .462]
ITSS	.411** (.155)	[.106, .715]	.062** (.023)	[.016, .108]
SSEFPR	.271 (.177)	[-.075, .617]	.054 (.035)	[-.015, .124]
ITSS * SSEFPR	-.114 (.252)	[-.608, .380]	-.016 (.036)	[-.087, .054]
RDEFPR	.992*** (.222)	[.556, 1.428]	.152*** (.034)	[.085, .218]
ITSS * RDEFPR	.210 (.298)	[-.375, .795]	.023 (.032)	[-.040, .085]
LNEFPR	.710*** (.203)	[.312, 1.108]	.109** (.032)	[.047, .172]
ITSS * LNEFPR	-.359 (.293)	[-.934, .216]	-.039 (.032)	[-.101, .023]

Note. This table presents unstandardized estimates (standard errors) and standardized estimates (standard errors) and 95% *CI* for unstandardized estimates for the moderation analysis of self-efficacy. ITSS = Intelligent Tutoring of Structure Strategy; GSRTPR = The Gray Silent Reading Test pretest; SSEFPR = structure strategy self-efficacy pretest; RDEFPR = reading self-efficacy pretest; LNEFPO = learning self-efficacy posttest; GSRTPO = The Gray Silent Reading Test posttest. * $p < .05$, ** $p < .01$, *** $p < .001$.

Chapter 5

Discussion

The current study aims to further the understanding of the effects of structure strategy instruction, delivered through the web-based intelligent tutoring system (ITSS), on reading comprehension and self-efficacy. Specifically, we examined how and for whom ITSS instruction affected reading comprehension and self-efficacy beliefs in academic tasks. The hypotheses that reading performance mediates and moderates the treatment effect of ITSS on self-efficacy beliefs were partially supported by the results, whereas the hypotheses that self-efficacy mediates and moderates the effect of ITSS on reading comprehension performance were rejected. Discussion over the mediation and moderation analyses is elaborated in the first two sections and followed by implications and limitations of the study.

5.1 The Effect of ITSS Instruction on Self-efficacy

This study furthers the investigation of the effects of ITSS instruction on a large sample of fourth and fifth graders' self-efficacy, by examining how and for whom ITSS lessons impacted students' confidence in fulfilling academic tasks of using structure strategy, reading, and learning. Our first research hypothesis (i.e., ITSS has an indirect effect on self-efficacy via reading comprehension) was supported by Grade 5 sample. Results suggested that reading comprehension had a significant mediating effect on the relationship between ITSS instruction and fifth-grade students' structure strategy self-efficacy and reading self-efficacy. That is, ITSS instruction impacted reading performance, which in turn enhanced children's perceived competence in using structure strategy and efficacy as readers. It suggests that effective strategy use is likely to

improve learners' performances in reading comprehension, and these successful experiences with reading tend to enhance their perceived capacities of completing strategy-related and reading-related tasks. However, the hypothesis was not supported for learning self-efficacy.

The finding suggests that the specificity level of the self-efficacy measure appears to impact the significance and strength of the mediation effect. ITSS instruction had comparable indirect effects on structure strategy self-efficacy ($\beta = .019$) and reading self-efficacy ($\beta = .021$) at posttest, because both measures are domain-specific and reading-related. Specifically, the former was used to assess students' perceived competence in writing main ideas or filling in signaling words, and the latter evaluated their confidence as readers. However, the items from learning self-efficacy measure were purported to assess learners' persistence in face with obstacles. The construct is domain-general and less susceptible to ITSS instruction than structure strategy self-efficacy and reading self-efficacy, which may explain the lack of significance of the mediating effect.

The potential mediating effect of reading comprehension may not be generalized to fourth-grade students. It is necessary to note that ITSS lessons delivered to fourth graders dropped the tasks of full recall due to teachers' complaints about too much typing for children, which may have limited their opportunities for practice (Wijekumar et al., 2012). Moreover, reading comprehension is considered a far-transfer outcome of structure strategy interventions (Hebert et al., 2016), particularly for fourth-grade students who just begin to encounter expository texts in school. Therefore, even though prior reading comprehension had significant, direct effects on self-efficacy beliefs, the lack of treatment effect on reading comprehension resulted in the non-significant indirect effects of ITSS on self-efficacies.

Meanwhile, this study adds evidence to the literature that supports the reciprocal relationship between reading comprehension and self-efficacy over time within the context of structure strategy instruction. Noticeably, the strength of the bidirectional effects is also

dependent on the specificity level of self-efficacy measures. Reading self-efficacy assessed a construct most relevant to reading comprehension, which ensured the strongest reciprocal relationship between them. Structure strategy self-efficacy was also related to reading comprehension, making it the second strongest. Learning self-efficacy was the least relevant, and thus had the weakest association with reading comprehension.

The second research hypothesis, that prior reading comprehension moderates the effect of ITSS instruction on self-efficacy, was also partially supported. For students in Grade 5, there was a significant interaction between ITSS instruction and prior reading comprehension on reading self-efficacy at posttest. ITSS instruction was found to exert a stronger impact on reading self-efficacy for fifth-grade under-achievers. That is to say, this intervention program appeared to help students who performed poorly on reading comprehension to build up their confidence in fulfilling reading-related tasks. Another plausible interpretation could be, as Wijekumar et al. (2014) stated, the ceiling effect; that is, students performed better on reading comprehension pretest already had a high level of reading self-efficacy, which limited the growth of reading self-efficacy at posttest. Although Unrau et al. (2018) concluded that prior reading performance did not significantly moderate the effect of reading interventions on reading self-efficacy, they found that struggling learners gained more from the treatment on reading self-efficacy than non-struggling and mixed learners when the treatment-control design was used, which is in line with our findings.

In summary, although ITSS instruction did not have a universal direct effect on learners' self-efficacy, it was expected to improve their confidence to adopt the structure strategy and efficacy as readers indirectly through promoting the growth of reading comprehension for fifth-grade students. Also, ITSS instruction appeared to be the most effective in improving reading self-efficacy for less proficient readers in fifth grade.

5.2 The Effect of ITSS Instruction on Reading Comprehension

The hypothesis that ITSS has an indirect effect on reading comprehension via self-efficacy is not supported. None of the self-efficacy measures were found to mediate the relationship between ITSS instruction and reading comprehension regardless of grade. For both fourth- and fifth-grade students, the web-based instruction did not have a significant, universal direct effect on self-efficacy beliefs at posttest, indicating that the instruction may not directly build students' confidence in fulfilling strategy-related, reading-related tasks, or improve their persistence with hard tasks. This finding contradicts with the previous study (Wijekumar et al., 2014) which found that ITSS significantly affected fifth-grade students' reading self-efficacy and structure strategy self-efficacy. The disparity could be attributed to the different analytic methodology used in the two studies. Wijekumar et al. (2014) used hierarchical linear modelling and tested each outcome variable one at a time, whereas this study used SEM and included all the outcome variables in one model.

Meanwhile, reading and learning self-efficacy at pretest had significant effects on students' reading comprehension, which is consistent with the finding of Wijekumar et al. (2014). Due to a lack of significant effect of ITSS instruction on self-efficacy, the mediating effect of self-efficacy is disconfirmed. The finding suggests that learning appropriate strategies may not directly improve students' perceived capabilities in practice, and it is more likely that successful experience with the adopted strategy builds up their confidence in completing relevant tasks, as Bandura proposed (1997).

The last hypothesis that prior self-efficacy moderates the relation between ITSS and reading comprehension is not supported either. Specifically, The ITSS group in Grade 4 did not significantly outperform the control group on reading comprehension after the instruction was delivered, and this result was universal regardless of their perceived competence in structure

strategy, reading, and learning at pretest. The ITSS classrooms in Grade 5 outperformed the control classrooms on reading comprehension and the treatment effect was universal across levels of self-efficacy beliefs they held before the intervention.

In summary, self-efficacy beliefs did not mediate nor moderate the effect of structure strategy instruction on reading comprehension. The findings suggest that first, reading comprehension may not be indirectly impacted by ITSS instruction through self-efficacy beliefs; and second, students' beliefs in capabilities before the treatment may not affect their benefitting from ITSS.

5.3 Implications

Fourth- and fifth-grade students are at a critical stage of developing skills for comprehending expository texts (Wijekumar et al., 2012; Wijekumar et al., 2014) and it is an essential time for students to build up their confidence in fulfilling tasks in this domain. This study furthers the understanding of the development of reading comprehension and self-efficacy at this transitioning period when the instruction of structure strategy was delivered.

First, it provides evidence that, even though the web-based program of structure strategy instruction may not directly improve students' self-efficacy, it could help students develop their perceived competence to use the text structure strategy and fulfill reading-related tasks through improving their performances in reading comprehension. It confirms that students' past experience (i.e., mastery experience) is an influential source of forming or modifying their self-efficacy beliefs in a related domain. Specifically speaking, ITSS instruction had a significant effect on fifth-grade students' reading comprehension, which in turn enhanced their self-efficacy; whereas fourth-grade students did not have such successful experience, or this experience was not

strong enough for them to improve their self-efficacy. In fact, Wijekumar et al. (2012) also attributed the small effect on reading comprehension to limited practice opportunities during the treatment. Therefore, increasing the treatment dosage, especially providing more practice tasks in diverse content areas for fourth-grade students would be recommended.

Second, this study indicates that fifth-grade under-achieving readers are likely to benefit more from ITSS on the development of reading self-efficacy. Similar results were found that students scoring lower on reading pretest gained more on reading posttest (Wijekumar et al., 2014). This suggests that ITSS instruction is particularly beneficial for below-average readers. As such, ITSS might offer a solution for poor readers to become more efficacious in reading, which may contribute to better use of self-regulatory strategies, higher engagement and persistence, and ultimately improve reading achievement in the future (Ahn & Bong, 2019).

Third, the standard ITSS was delivered in this study, indicating that students went over all the lessons in a fixed order (Wijekumar et al., 2014). Bandura (1997) asserted that an individual's perception of competence would be largely enhanced when he had successful experiences in overcoming challenging tasks. Given that only below-average students improved reading self-efficacy after the treatment, a possible explanation could be that the instructional tasks might not be at an optimal difficulty level for those who scored at or above average in reading pretest. In fact, Meyer et al. (2011) concluded that individualized ITSS, designed to meet the needs of each learner, exerted stronger impacts on fifth graders' reading comprehension than standard ITSS. A potential implication of this finding is to tailor instruction according to students' prior reading skills and make the learning tasks more challenging for more skilled readers. The lack of significant ITSS effect on reading self-efficacy for more advanced readers could also be due to the ceiling effect of the measure. Future studies could refine the measure or choose one that is more sensitive to intervention for more advanced readers.

Lastly, the reciprocal relationship between reading comprehension and self-efficacy is generally supported by the longitudinal data. That is, prior reading comprehension predicts subsequent self-efficacy controlling for prior self-efficacy; and prior self-efficacy predicts subsequent reading comprehension controlling for prior reading comprehension. The finding integrates the self-enhancement model (i.e., self-attitudes is the determinant of academic skill) and skill development model (i.e., academic skill is the driver of self-attitude) (Burns et al., 2019) by stating that self-efficacy beliefs and reading skill are determinants of one another and influencing each other reciprocally.

The strength of the reciprocal relationship varies across the specificity level of self-efficacy measure used. In this study, reading self-efficacy assessed one's perceived competence as a reader which is the most relevant to reading comprehension, therefore it has the strongest association with reading outcome. Structure strategy self-efficacy measured one's perceived confidence in writing main ideas and filling in signal words using the structure strategy, which is also relevant to reading comprehension, and thus has the second strongest connection with reading outcome. Learning self-efficacy evaluated one's perceived learning persistence while encountering difficulties, which is the least relevant to reading comprehension. Even though learning persistence may contribute to the development of reading comprehension, the measure is too general to be used because it does not clarify the task domain and range of situations (Bandura, 1997). Therefore, a task-specific or domain-specific measure of self-efficacy is recommended to test the reciprocal relationship between reading comprehension and self-efficacy.

5.4 Limitations

There are several limitations in this study. First, this study used students' self-reported efficacy ratings. Researchers have raised concerns over the use of self-reported measures, and Bandura (1997) also mentioned that students may have inaccurate perceptions of competence when they do not have sufficient knowledge about the domain. Also, the reliability for some self-efficacy measures was relatively low, especially for learning self-efficacy (Cronbach's $\alpha < .7$). Therefore, self-efficacy measures designed to target specific tasks in the context of ITSS instruction, such as self-efficacy in reading expository texts, should be developed and used in the future research.

Second, the current data were collected on two occasions, which limited our choice of longitudinal models. Cole and Maxwell (2003) stated concerns over the half-longitudinal mediation model in that it does not allow us to test whether the mediator variable completely mediates the effect of the predictor on the outcome, and the stationarity assumption cannot be tested with two occasions. Future research should be conducted with longitudinal data collected on three or more occasions to confirm the findings.

Lastly, ITSS is a web-based program designed for structure strategy instruction, therefore the findings of this study may not be generalized to the traditional classroom instruction of structure strategy and other human tutoring interventions.

References

Adams, M. J. (2004). Modeling the connections between word recognition and reading. In R. B. Ruddell, M. R. Ruddell, & H. Singer (Eds.), *Theoretical Models and Processes of Reading* (pp. 1219-1243). Newark, DE: International Reading Association.

Ahn, H. S., & Bong, M. (2019). Self-efficacy in learning: Past, present, and future. In K. Renninger & S. Hidi (Eds.), *The Cambridge handbook of motivation and learning* (pp. 63-86). Cambridge, England: Cambridge University Press.

Anderson, R. C., Hiebert, E, H., Scott, J, A., & Wilkinson, I, A. (1985). *Becoming a nation of readers: The report of the commission on reading*. Retrieved from http:// files.eric.ed.gov/fulltext/ED253865.pdf

Andreassen, R., & Bråten, I. (2010). Examining the prediction of reading comprehension on different multiple-choice tests. *Journal of Research in Reading*, *33*(3), 263–283. Retrieved from https://doi.org/10.1111/j.1467-9817.2009.01413.x

Anmarkrud, Ø., & Bråten, I. (2009). Motivation for reading comprehension. *Learning and Individual Differences*, *19*(2), 252–256. Retrieved from https://doi.org/10.1016/j.lindif.2008.09.002

Anthony, J. L., & Francis, D. J. (2005). Development of phonological awareness. *Current Directions in Psychological Science*, *14*(5), 255–259.

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.

Asparouhov, T., & Muthén, B. O. (2005). Multivariate statistical modeling with survey data. *Proceedings of the Federal Committee on Statistical Methodology (FCSM) Research*

Conference, 1–30. Retrieved from https://www.statmodel.com/download/2005FCSM.pdf

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. Retrieved from https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, *44*(9), 1175–1184.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman and Company.

Bandura, A. (2001). SOCIAL COGNITIVE THEORY : An agentic perspective. *Annual Review of Psychology*, *2001*(52), 1–26.

Bartlett, B. J. (1978). *Top-level structure as an organizational strategy for recall of classroom text* (Doctoral dissertation). University Microfilms International: Ann Arbor, Mich.

Benson, J. (1989). Structural components of statistical test anxiety in adults: An exploratory model. *Journal of Experimental Education*, *57*(3), 247–261. Retrieved from https://doi.org/10.1080/00220973.1989.10806509

Bong, M., Cho, C., Ahn, H. S., & Kim, H. J. (2012). Comparison of self-beliefs for predicting student motivation and achievement. *Journal of Educational Research*, *105*(5), 336–352. Retrieved from https://doi.org/10.1080/00220671.2011.627401

Bouffard-Bouchard, T. (1994). Effect of activating conditional knowledge on self-efficacy and comprehension monitoring. *International Journal of Behavioral Development* (Vol. 17, pp. 577–592). Retrieved from https://doi.org/10.1177/016502549401700311

Bråten, I., Ferguson, L. E., Anmarkrud, Ø., & Strømsø, H. I. (2013). Prediction of learning and comprehension when adolescents read multiple texts: The roles of word-level processing, strategic approach, and reading motivation. *Reading and Writing*, *26*(3), 321–348. Retrieved

from https://doi.org/10.1007/s11145-012-9371-x

Burns, R. A., Crisp, D. A., & Burns, R. B. (2019). Re-examining the reciprocal effects model of self-concept, self-efficacy, and academic achievement in a comparison of the cross-lagged panel and random-intercept cross-lagged panel frameworks. *British Journal of Educational Psychology*, 1–15. Retrieved from https://doi.org/10.1111/bjep.12265

Carrell, P. L. (1985). Facilitating ESL reading by teaching text structure. *TESOL Quarterly, 19*(4), 727-752.

Cole, D. A., & Maxwell, S. E. (2003). Testing mediational models with longitudinal data: Questions and tips in the use of structural equation modeling. *Journal of Abnormal Psychology*, *112*(4), 558–577. Retrieved from https://doi.org/10.1037/0021-843X.112.4.558

Cook, L. K., & Mayer, R. E. (1988). Teaching Readers About the Structure of Scientific Text. *Journal of Educational Psychology*, *80*(4), 448–456. Retrieved from https://doi.org/10.1037/0022-0663.80.4.448

Culatta, B., Hall-Kenyon, K. M., & Black, S. (2010). Teaching expository comprehension skills in early childhood classrooms. *Topics in Language Disorders*, *30*(4), 323–338. Retrieved from https://doi.org/10.1097/TLD.0b013e3181ff5a65

Davis, J. N., Lange, D. L., & Samuels, S. J. (1988). Effects of text structure instruction on foreign language readers' recall of a scientific journal article. *Journal of Literacy Research*, *20*(3), 203–214. Retrieved from https://doi.org/10.1080/10862968809547639

Duke, N. K., & Carlisle, J. (2011). The development of comprehension. In M. Kamil, P. Pearson, E. Moje, & P. Afflerbach (Eds.), *Handbook of Reading Research* (Vol. IV, pp. 199-228). NY, NY: Routledge.

Enders, C. K. (2001). The impact of nonnormality on full information maximum-likelihood estimation for structural equation models with missing data. *Psychological Methods, 6*(4), 352–370. Retrieved from https://doi.org/10.1037/1082-989x.6.4.352

Frankel, K. K., Pearson, P. D., & Nair, M. (2011). Reading comprehension and reading disability. In A. McGill-Franzen & R. Allington (eds.), *Handbook of Reading Disability Research* (pp. 219-231). New York, NY: Routledge.

Gambrell, L. B., Palmer, B. M., Codling, R. M., & Gambrell, L. B. (1996). Assessing motivation to read. *The Reading Teacher, 49*(7), 518–533.

Graham, S., & Weiner, B. (2012). Motivation: Past, present, and future. In K. Harris, S. Graham, T. Urdan, C. McCormick, G. Sinatra, & J. Sweller (Eds.), *Educational Psychology Handbook* (pp. 367–397). Retrieved from https://doi.org/10.1037/13273-013

Guthrie, J. T., Hoa, A. L. W., Wigfield, A., Tonks, S. M., Humenick, N. M., & Littles, E. (2007). Reading motivation and reading comprehension growth in the later elementary years. *Contemporary Educational Psychology*, (32), 282–313.

Hebert, M., Bohaty, J. J., Nelson, J. R., & Brown, J. (2016). The effects of text structure instruction on expository reading comprehension: A meta-analysis. *Journal of Educational Psychology*, *108*(5), 609–629. Retrieved from https://doi.org/10.1037/edu0000082

Hiebert, E. H., Englert, C. S., & Brennan, S. (1983). Awareness of text structure in recognition and production of expository discourse. *Journal of Reading Behavior, XV*(4), 63–79.

Honicke, T., & Broadbent, J. (2016). The influence of academic self-efficacy on academic performance: A systematic review. *Educational Research Review*, *17*, 63–84. Retrieved from https://doi.org/10.1016/j.edurev.2015.11.002

Hornstra, L., Van Der Veen, I., Peetsma, T., & Volman, M. (2013). Developments in motivation and achievement during primary school: A longitudinal study on group-specific differences. *Learning and Individual Differences*, *23*(1), 195–204. Retrieved from https://doi.org/10.1016/j.lindif.2012.09.004

Kelley, H. M., Siwatu, K. O., Tost, J. R., & Martinez, J. (2015). Culturally familiar tasks on reading performance and self-efficacy of culturally and linguistically diverse students.

Educational Psychology in Practice, *31*(3), 293–313. Retrieved from https://doi.org/10.1080/02667363.2015.1033616

Kendeou, P., Van Den Broek, P., Helder, A., & Karlsson, J. (2014). A cognitive view of reading comprehension: Implications for reading difficulties. *Learning Disabilities Research and Practice*, *29*(1), 10–16. Retrieved from https://doi.org/10.1111/ldrp.12025

Kintsch, W., & van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psychological Review*, *85*(5), 363–394. Retrieved from https://doi.org/10.1037/0033-295X.85.5.363

Kline, R. B. (2016). *Principles and practice of structural equation modeling (4th ed.).* New York, NY: Guilford Press.

Lau, K. L. (2018). Hong Kong senior secondary students' reading motivation and classical Chinese reading comprehension. *Reading and Writing*. Retrieved from https://doi.org/10.1007/s11145-018-9897-7

Linnenbrink-Garcia, L., & Patall, E. A. (2016). Motivation. In L. Corno & E. Anderman (Eds.), *Handbook of Educational Psychology* (pp. 91-103). Routledge/Taylor & Francis Group.

Little, T. D. (2013). *Longitudinal structural equation modeling*. New York, NY: Guilford Press.

Ma, W., Adesope, O. O., Nesbit, J. C., & Liu, Q. (2014). Intelligent tutoring systems and learning outcomes: A meta-analysis. *Journal of Educational Psychology*, *106*(4), 901–918. Retrieved from https://doi.org/10.1037/a0037123

Maydeu-Olivares, A. (2017). Maximum likelihood estimation of structural equation models for continuous data: Standard errors and goodness of fit. *Structural Equation Modeling*, *24*(3), 383–394. Retrieved from https://doi.org/10.1080/10705511.2016.1269606

Menon, S. & Heibert, E.H. (2011). Instructional texts and the fluency of disabled readers. In A. McGill-Franzen & R. L. Allington (Eds.), *Handbook of Reading Disability Research* (pp. 57-67). New York, NY: Routledge.

Meyer, B. J. F. (1975). *The organiztion of prose and its effects on memory*. Amsterdam: North-Holland Publishing Company.

Meyer, B. J. F. (1985). Prose analysis: Purposes, procedures, and problems. In B. K. Britton & J. Black (Eds.), *Analyzing and understanding expository text* (pp. 11-64, 269-304). Hillsdale, NJ: Erlbaum.

Meyer, B. J. F. (2009). BJM questionnaire document creation 8-26-2009. The Pennsylvania State University (April 26, 2009).

Meyer, B. J. F., Brandt, D. M., & Bluth, G. J. (1980). Use of top-level structure in text: Key for reading comprehension of ninth-grade students. *Reading Research Quarterly*, *16*(1), 72–103.

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

Meyer, B. J., & McConkie, G. W. (1973). What is recalled after hearing a passage? *Journal of Educational Psychology*, *65*(1), 109–117. Retrieved from https://doi.org/10.1037/h0034762

Meyer, B. J. F., Middlemiss, W., Theodorou, E., Brezinski, K. L., McDougall, J., & Bartlett, B. J. (2002). Effects of structure strategy instruction delivered to fifth-grade children using the internet with and without the aid of older adult tutors. *Journal of Educational Psychology*, *94*(3), 486–519. Retrieved from https://doi.org/10.1037/0022-0663.94.3.486

Meyer, B. J. F, & Poon, L. W. (2001). Effects of structure strategy training and signaling on recall of text. *Journal of Educational Psychology*, *93*(1), 141–159. Retrieved from https://doi.org/10.1037/0022-0663.93.1.141

Meyer, B. J. F., & Ray, M. N. (2011). Structure strategy interventions: Increasing reading comprehension of expository text. *International Electronic Journal of Elementary Education*, *4*(1), 127–152.

Meyer, B. J. F., & Rice, G. E. (1982). The interaction of reader strategies and the organization of text. *Text, Interdisciplinary Journal for the Study of Discourse, 2,* 155-192.

Meyer, B. J. F., & Rice, G, E. (1984). The structure of text. In P. Pearson & M. Kamil (Eds.), *Handbook of research in reading* (pp. 319-351). New York: Longman.

Meyer, B. J. F., Wijekumar, K., & Lei, P. (2018). Comparative signaling generated for expository texts by 4th–8th graders: Variations by text structure strategy instruction, comprehension skill, and signal word. *Reading and Writing*, *31*(9), 1937–1968. Retrieved from https://doi.org/10.1007/s11145-018-9871-4

Meyer, B. J. F., Wijekumar, K., & Lin, Y. C. (2011). Individualizing a web-based structure strategy intervention for fifth graders' comprehension of nonfiction. *Journal of Educational Psychology*, *103*(1), 140–168. Retrieved from https://doi.org/10.1037/a0021606

Meyer, B. J. F., Wijekumar, K., Middlemiss, W., Higley, K., Lei, P., Meier, C., & Spielvogel, J. (2010). Web-based tutoring of the structure strategy with or without elaborated feedback or choice for fifth- and seventh-grade readers. *Reading Research Quarterly*, *45*(1), 62-92.

Meyer, B. J. F., Young, C. J., & Bartlett, B. J. (1989). *Memory improved: enhanced reading comprehension and memory across the life span through strategic text structure*. Hilldale: Erlbaum.

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology*, *38*(1), 30–38. Retrieved from https://doi.org/10.1037/0022-0167.38.1.30

Muthén, L. K., & Muthén, B. O. (1998-2017). *Mplus User's Guide (8th edition)*. Los Angeles, CA: Muthén & Muthén.

National Center for Education Statistics. (2017). *National Assessment of Educational Progress: An overview of NAEP*. Washington, D. C.: National Center for Education Statistics, Institute of Education Sciences, U.S. Dept. of Education.

Raymond, P. M. (1993). The effects of structure strategy training on the recall of expository prose for university students reading French as a second language. *The Modern Language Journal*, *77*(4), 445-458.

Relich, J. D., Debus, R. L., & Walker, R. (1986). The mediating role of attribution and self-efficacy variables for treatment effects on achievement outcomes. *Contemporary Educational Psychology*, *11*(3), 195–216. Retrieved from https://doi.org/10.1016/0361-476X(86)90017-2

Schunk, D. H. (1981). Modeling and attributional effects on children's achievement: A self-efficacy analysis. *Journal of Educational Psychology*, *73*(1), 93–105. Retrieved from https://doi.org/10.1037/0022-0663.73.1.93

Shell, D. F., Colvin, C., & Bruning, R. H. (1995). Self-Efficacy, attribution, and outcome expectancy mechanisms in reading and writing achievement: grade-level and achievement-level differences. *Journal of Educational Psychology*, *87*(3), 386–398. Retrieved from https://doi.org/10.1037/0022-0663.87.3.386

Sherer, M., & Maddux, J. E. (1982). The self-efficacy scale: construction and validation. *Psychological Reports*, *51*, 663–671.

Sitzmann, T., & Yeo, G. (2013). A meta-analytic investigation of the within-person self-efficacy domain: Is self-efficacy a product of past performance or a driver of future performance? *Personnel Psychology*, *66*(3), 531–568. Retrieved from https://doi.org/10.1111/peps.12035

Taylor, B. M. (1980). Children's memory for expository text after reading. *Reading Research Quarterly*, *15*(3), 399–411.

Taylor, B. M. (1982). Text structure and children's comprehension and memory for expository material. *Journal of Educational Psychology*, *74*(3), 323–340. Retrieved from https://doi.org/10.1037/0022-0663.74.3.323

Taylor, B. M., & Beach, R. W. (1984). The effects of text structure instruction on middle-grade

students' comprehension and production of expository text. *Reading Research Quarterly*, *19*(2), 134–146.

Unrau, N. J., Rueda, R., Son, E., Polanin, J. R., Lundeen, R. J., & Muraszewski, A. K. (2018). Can reading self-efficacy be modified? A mata-analysis of the impact of interventions on reading self-efficacy. *Review of Educational Research*, *88*(2), 167–204.

Usher, E. L., & Pajares, F. (2008). Sources of self-efficacy in school: Critical review of the literature and future directions. *Review of Educational Research*, *78*(4), 751–796. Retrieved from https://doi.org/10.3102/0034654308321456

Wiederholt, J. L., & Blalock, G. (2000). *Gray Silent Reading Tests*. Austin, TX: PRO-ED.

Wigfield, A., Gladstone, J., & Turci, L. (2016). Beyond cognition: reading motivation and reading comprehension. *Child Development*, *10*(3), 190–195. Retrieved from https://doi.org/10.1016/j.physbeh.2017.03.040

Wijekumar, K. K., Meyer, B. J. F., & Lei, P. (2012). Large-scale randomized controlled trial with 4th graders using intelligent tutoring of the structure strategy to improve nonfiction reading comprehension. *Educational Technology Research and Development*, *60*(6), 987–1013. Retrieved from https://doi.org/10.1007/s11423-012-9263-4

Wijekumar, K., Meyer, B. J. F., & Lei, P. (2013). High-fidelity implementation of web-based intelligent tutoring system improves fourth and fifth graders content area reading comprehension. *Computers and Education*, *68*, 366–379. Retrieved from https://doi.org/10.1016/j.compedu.2013.05.021

Wijekumar, K, Meyer, B. J. F., & Lei, P. (2017). Web-based text structure strategy instruction improves seventh graders' content area reading comprehension. *Educational Psychology*, *109*(6), 741–760.

Wijekumar, K., Meyer, B. J. F., Lei, P., Cheng, W., Ji, X., & Joshi, R. M. (2017). Evidence of an intelligent tutoring system as a mindtool to promote strategic memory of expository texts

and comprehension with children in Grades 4 and 5. *Journal of Educational Computing Research*, *55*(7), 1022–1048. Retrieved from https://doi.org/10.1177/0735633117696909

Wijekumar, K., Meyer, B. J. F., Lei, P. W., Lin, Y. C., Johnson, L. A., Spielvogel, J. A., … Cook, M. (2014). Multisite randomized controlled trial examining intelligent tutoring of structure strategy for fifth-grade readers. *Journal of Research on Educational Effectiveness*, *7*(4), 331–357. Retrieved from https://doi.org/10.1080/19345747.2013.853333

Williams, J. P. (2005). Instruction in reading comprehension for primary-grade students: A focus on text structure. *Journal of Special Education*, *39*(1), 6–18. Retrieved from https://doi.org/10.1177/00224669050390010201

Williams, J. P., Kao, J. C., Pao, L. S., Ordynans, J. G., Atkins, J. G., Cheng, R., & DeBonis, D. (2016). Close analysis of texts with structure (CATS): An intervention to teach reading comprehension to at-risk second graders. *Journal of Educational Psychology*, *108*(8), 1061–1077. Retrieved from https://doi.org/10.1037/edu0000117

Williams, J. P., Nubla-kung, A. M., Pollini, S., Stafford, K. B., Garcia, A., & Snyder, A. E. (2007). Teaching cause-effect text studies content to at-risk second graders. *Journal of Learning Disabilities*, *40*(2), 111–120.

Williams, J. P., Pollini, S., Nubla-Kung, A. M., Snyder, A. E., Garcia, A., Ordynans, J. G., & Grant Atkins, J. (2014). An intervention to improve comprehension of cause/effect through expository text structure instruction. *Journal of Educational Psychology*, *106*(1), 1–17. Retrieved from https://doi.org/10.1037/a0033215

Williams, J. P., Stafford, K. B., Lauer, K. D., Hall, K. M., & Pollini, S. (2009). Embedding reading comprehension training in content-area instruction. *Journal of Educational Psychology*, *101*(1), 1–20. Retrieved from https://doi.org/10.1037/a0013152

Yeh, L. H., Schwartz, A. I., & Baule, A. L. (2011). The impact of text-structure strategy instruction on the text recall and eye-movement patterns of second language English learners. *Reading Psychology*, 32, 495-519.

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: an overview. *Educational Psychologist*, *25*(1), 3–17.