THE EFFECTS OF WEB-BASED TEXT STRUCTURE STRATEGY ON ADULT CHINESE ELLS' READING STRATEGIES AND READING COMPREHENSION

A Dissertation

by

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ABSTRACT

The inability to develop reading comprehension skills can limit academic success across many fields, especially for English Language Learners (ELLs). The current study investigated whether the structure strategy, delivered through the Intelligent Tutoring of Structure Strategy (ITSS) to adult Chinese ELLs, can improve students' reading strategies, thus improving their reading comprehension. With a quasi-experimental nonequivalent control group design, 207 adult Chinese ELLs from four classes were assigned to experimental or comparison groups. The experimental group utilized the ITSS to support their English reading instruction, whereas the comparison group used traditional instruction. My results indicated that the ITSS intervention had a statistically significant positive effect on adult Chinese ELLs' reading comprehension ($\beta=3.07$, $p<0.001$) with Cohen's d = 0.43 on College English Test-4 (CET-4). Furthermore, I found that Chinese ELLs reported using more higher-order reading strategies ($p<0.01$) after the intervention. However, there was no significant change in reported reading strategies in the comparison group between pretest and post-test. The current study did not provide evidence that the change of reading strategies mediated the relationship between the intervention/control condition and Chinese ELLs' reading comprehension.

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NOMENCLATURE

CET	College English Test
ELL	English Language Learner
ITSS	Intelligent Tutoring of Structure Strategy
TOEFL	Test of English as a Foreign Language
TSM	Text Structure Model
TSS	Text Structure Strategy

CONTRIBUTORS AND FUNDING SOURCES

Contributors

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CHAPTER I

INTRODUCTION

The failure to develop reading comprehension skills creates a significant obstacle for academic success and life-long learning (Perfetti, Landi, & Oakhill, 2005). Reading comprehension refers to the ability to select important ideas and construct meaning through interactions with a text. It can be predicted by measuring decoding and comprehension abilities (Joshi & Aaron, 2000; Snow, Burns, & Griffin, 1998).

Reading comprehension presents a substantial challenge for native English speakers (e.g., National Assessment of Educational Progress, 2015). English language learners (ELLs) may encounter greater challenges with reading comprehension than their monolingual peers (August & Shanahan, 2008; Wijekumar, Meyer, Lei, Hernandez, & August, 2017). Since Chinese has many contrasting characteristics to English (Perfetti, 1999; Perfetti, Zhang, & Berent, 1992), English reading comprehension for Chinese ELLs might be even more difficult than the experiences of other ELLs.

Previous studies indicated that the higher-level processing of reading is a universal cognitive activity independent of the language system (Chen & Juola, 1982; Hung & Tzeng, 1981). Similar to the learners in the United States or European countries (Dole, Brown, & Trathen, 1996; Paris, Lipson, & Wixson, 1994), Lau and Chan (2003) found that Chinese readers with poor reading skills were less proficient than average readers in higher-order comprehension skills, such as recognizing and summarizing main ideas, identifying text structures, detecting errors, and inferring implicit meanings in texts.

The text structure model (TSM) of reading presents a theoretical basis to approach Chinese ELLs' reading challenges by focusing on selecting important ideas while reading and presenting logical connections between the ideas to create an integrated long-term memory structure (Meyer, 1987). The text structure strategy (TSS) is the instructional implementation of the TSM and is designed to help students generate hierarchical and logically connected memory from texts guided by five text structures: comparison, problem and solution, cause and effect, sequence, and description (Meyer, 1987; Meyer, Brandt, & Bluth, 1980). Empirical research about the TSS shows that using the text structures improves reading comprehension by helping readers identify the underlying purpose of writing, select important information through scaffolding, encode the connections between important ideas logically (e.g., the cause is ___and the effect is ____), and integrate the information in the text with readers' prior knowledge (Meyer, 1975; Wijekumar, Meyer, & Lei, 2017). The current study employed the Intelligent Tutoring of Structure Strategy (ITSS) to investigate the effects of the TSS on the transformation of adult Chinese ELLs' reading strategies, overall reading comprehension skills, and higher-order comprehension skills.

There is a growing body of evidence supporting the TSS as effective in improving comprehension outcomes for readers of various age groups such as primary and middle school students, college students, and older adults (e.g., Meyer, 1975; Wijekumar, Meyer, & Lei, 2012, 2017; Williams, Hall, & Lauer, 2004). However, few studies have attempted to compare the effectiveness of the TSS on lower-order reading comprehension skills, such as simple recall, and its effectiveness on the higher-order reading comprehension

skills such as inference (Basaraba, Yovanoff, Alonzo, & Tindal, 2013; Davey, 1988; Miller & Smith, 1985; Perfetti et al., 2005). The current study attempted to explore whether the TSS had a greater influence on adult Chinese ELLs' higher-order reading comprehension skills related to summarization and inference.

Even though existing research studies have examined whether the TSS can improve monolingual learners' reading comprehension, more research is needed to understand the effect of TSS on ELLs' reading comprehension. Reading informational texts, for instance, is particularly challenging for ELLs since the organization of informational texts is different from narrative texts, and informational texts present readers with unfamiliar concepts and complex relationships between ideas (August, Carlo, Dressler, & Snow, 2005; Minaabad, 2017). While ELLs also struggle with a relative lack of vocabulary knowledge compared to their monolingual peers, the informational texts may create additional difficulties for comprehension because ELLs lack comprehension strategies (August & Shanahan, 2008; McNeil, 2011). Preliminary research studies which used the TSS with Spanish-speaking ELLs showed positive effects (e.g., Wijekumar, et al., 2017). These positive results may have been influenced by the shared orthography between English and Spanish. Therefore, the replication of these findings with speakers of other languages such as Chinese is necessary and important for understanding the effects of the TSS on other groups of ELLs.

Furthermore, even though research has shown that students using ITSS have outperformed the students in the control classrooms (Wijekumar et al., 2012, 2017; Wijekumar et al., 2014), the studies have focused primarily on standardized and

researcher-designed measures of reading comprehension. The researcher-designed measures also presented evidence that students using the ITSS were able to generate effective main ideas (Wijekumar et al., 2012, 2017). According to Block (1986), the cognitive efforts for meaning retrieval and processing cannot be observed directly by examining a reading comprehension test score. Therefore, I sought to go beyond the test scores and understand how TSS may alter the reading process or the reading strategies used for reading comprehension through pre- and post-surveys about the students' use of reading strategies.

The purpose of the current study was to investigate the effects of ITSS on adult Chinese ELLs' English reading comprehension, especially their higher-order reading comprehension skills such as inference generation. Furthermore, the study attempted to explore how ITSS use changed the adult Chinese ELLs' reading strategies and understand whether the transformation of Chinese ELLs' reading strategies mediated the effect of ITSS on reading comprehension.

CHAPTER II

LITERATURE REVIEW

The current study examined the effect of ITSS on adult Chinese ELLs' reading comprehension. I was especially interested in investigating the effect of ITSS on adult Chinese ELLs' higher-order reading comprehension skills, particularly inference generation. I hypothesized that ITSS instruction would affect the use of adult Chinese ELLs' reading strategies. Specifically, after ITSS instruction, I expected the learners to employ more higher-level reading strategies during reading such as summarization and inference. Therefore, the study attempted to explore the self-reported changes in Chinese ELLs' reading strategies through the pre- and post-surveys and investigate whether the transformation of reading strategies mediated the effects of ITSS on reading comprehension, especially on readers' higher-order comprehension skills.

Chapter Two first presents the theoretical framework for the current study by comparing TSS with the other major reading models. Next, the challenges that Chinese ELLs encounter in both L1 and L2 reading are synthesized. This chapter then illustrates why the current study was needed by examining recent intervention studies about Chinese ELLs' reading comprehension. This literature review is followed by an explanation of why I employed ITSS in this study, and some key features of ITSS are introduced. Finally, Chapter Two includes a summary of a pilot study using ITSS with Chinese ELLs before presenting the research questions.

Theoretical Framework for the Current Study

The text structure model of reading helps readers to focus on seeking coherence through the top-down process of connecting ideas using five text structures: comparison, cause and effect, problem and solution, description, and sequence (Meyer, 1987; Meyer et al., 1980). TSS, the instructional strategy associated with the TSM, enables readers to comprehend the logical structure used by an author to select important ideas and generate main ideas (Meyer, Wijekumar, & Lin, 2011). Readers who use the TSS approach have been shown to be competent in utilizing the author's top-level structure to process text so that they can construct an integrated representation of a text, understand the author's intent for writing, and eventually comprehend the author's message (Meyer, 1987; Meyer et al., 1980; Meyer & Poon, 2001).

One of the reasons why TSS works is that the TSS approach emphasizes the function of signaling words in reading passages. By identifying the signaling words, readers can recognize the text structure used by the author. If a writer does not provide signaling words, the reader must infer the appropriate logical relationship among propositions. Detailed information about the five structures and signaling words is included in Table 1.

Table 1

Five Basic Text Structures and their Signals

Structures	**Signals**
Comparison: the information is organized in parts that offer a comparison, contrast, or alternative perspective on a topic.	but, in contrast, instead, however, different, compared to, etc.
Problem/solution: the main ideas are organized into a problem part and a solution part.	Problem: problem, question, puzzle, issue, the trouble, etc. Solution: solution, answer, response, reply, to satisfy the problem, to solve these problems, etc.
Cause/effect: the main ideas are organized into cause and effect parts.	as a result, because, since, for the purpose of, led to, thus, the reason, therefore, etc.
Sequence: the main idea is procedure or time related.	afterwards, later, finally, early, to begin with, then, in the first place, before, after, etc.
Description: the main idea is that features of a topic are discussed.	for example, for instance, such as, characteristics are, in describing, etc.

Note. Adapted from Meyer & Poon (2001)

The TSM focuses on similar goals with other major theoretical models for reading comprehension, such as schema theory (Anderson, 1984; Anderson, Spiro, & Anderson, 1978), Kintsch and van Dijk's (1978) construction-integration (CI) model (van Dijk & Kintsch, 1983), the landscape model (Van den Broek, young Tzeng, & Linderholm, 1999), and the reading systems framework (Perfetti & Stafura, 2014). All of the reading models and the TSM describe basic and overall reading comprehension processes and focus on activities involved in understanding written text—the words, the sentences, and the relations between the sentences and ideas (for detailed description of the reading models, see Table 2).

Table 2

Major Theoretical Models for Reading

Major Theoretical Models for Reading	*Brief Conceptual Description*	*Theorists*
Schema Theory	According to schema theory, readers can comprehend a message when they can bring to mind a schema that gives a good account of the things, events, or situations described in the message. Schema theory highpoints that multiple versions of interpretation of a text are possible. Readers comprehend the same text according to their own schema, which depends upon the readers' age, sex, race, religion, nationality, and occupation.	Anderson, 1984 Anderson et al., 1978
CI Model	The CI model is composed of two major comprehension processes—construction and integration. The construction processes result in an initial, enriched, but incoherent textbase. The textbase is then subjected to an integration process to form a coherent structure. According to CI model, the mental representations that are constructed comprise both a text-specific and a situation-specific component.	Kintsch & van Dijk, 1978
The Landscape Model	The landscape model is designed to simulate the flux of concept activation during reading. The landscape model assumes that readers process information in reading cycles, with each cycle corresponding to a sentence or proposition. The consequence of an effective reading process is a coherent mental representation of the information according to the landscape model.	Van den Broek, Rapp, Kendeou, 2005 Van den Broek, Young, Tzeng, & Linderholm, 1999

(continued)

Table 2 continued

Major Theoretical Models for Reading	*Brief Conceptual Description*	*Theorists*
The Simple View of Reading	From the standpoint of the simple view of reading, reading is composed of two parts: decoding and linguistic comprehension. The two parts are equally important but neither sufficient by itself. Based on this understanding, if reading (R), decoding (D), and linguistic comprehension (L) are each regarded as variables ranging from 0 (null) to 1 (perfection), then the simple view of reading can be expressed as R = D *L.	Hoover & Gough, 1990 Gough & Tunmer, 1986
The Component model of Reading	The component model of reading proposed a revised model of reading, R=D*C+S (speed of process). This model found that even though the product and additive indices of decoding and comprehension predict reading achievement to a similar extent (approximately 50% of the variance in reading comprehension can be explained by two factors), the product index appears to be a better formula since it can deal with a wider range of reading abilities. In addition, adding speed of process to the simple view formula improves prediction of reading comprehension by 10.24%.	Joshi, & Aaron, 2000
The Reading Systems Framework	The Reading Systems Framework claims that: 1) linguistic knowledge, orthographic knowledge, and general knowledge about the world (for example, text genres) are used in reading; 2) readers process the knowledge sources—decoding, meaning retrieval, inferencing, and comprehension monitoring—in both constrained ways and interactive ways; 3) these processes occur within a cognitive system that has pathways between perceptual and long-term memory systems.	Perfetti & Stafura, 2014

(continued)

Table 2 continued

Major Theoretical Models for Reading	*Brief Conceptual Description*	*Theorists*
The Text Structure Model of Reading	The text structure strategy (TSS) facilitates readers to focus on seeking coherence through the top-down process of connecting ideas using five text structures: comparison, cause and effect, problem and solution, description, and sequence. Readers who use the TSS approach have been shown to be competent in utilizing the author's top-level structure to process text so that they can better comprehend the author's message.	Meyer, Brandt, & Bluth, 1980 Meyer, 1987 Meyer & Poon, 2001

The TSM, CI model (van Dijk & Kintsch, 1983), and landscape models (Taylor, Graves, & van den Broek, 2000; Yeari & van den Broek, 2011) share some common ground. They all place an equal emphasis on top–down processing and bottom-up processing. They all require the readers to integrate the text information with prior knowledge, focus on memory structures, and make interactions between text and task (e.g., Bohn-Gettler & Kendeou, 2014; Rice, Meyer, & Miller, 1989). Although they share many core features, the TSS is more explicit, precise, and transparent in scaffolding the readers to understand the key elements of the text through the five text structures (Wijekumar, Meyer, & Lei, 2017).

According to Wijekumar et al. (2017), the variations of the three approaches lie in the implementation of these models during instruction about reading comprehension. For example, the implementations of the CI model focus on summarizing, cohesion of text,

and inferences. Since the landscape model and the CI model emphasize the importance of integrating readers' prior knowledge, the readers might encounter reading difficulties when they lack related background knowledge for a passage. Therefore, the instructional approaches using the CI or landscape models often focus on repeated-reading of the text for summarizing with feedback given to scaffold the construction of effective summaries (e.g., Caccamise, Friend, Groneman, Littrell-Baez, & Kintsch, 2014). In contrast, TSS instruction utilizes more explicit and transparent activities for each text structure to aid the readers to select important ideas and generate the main idea or summary. For instance, specific instructions were given to readers to identify who was being compared with whom and on what basis they were compared if the reading passage compared two or more people (e.g., Comparison pattern: _____ and _____ were compared on ____, ____, and ____).

Studies have found that after the TSS intervention, students improve their understanding of the organization of a text by identifying signaling words and structures of the text and generating main ideas (Meyer, 1985; Meyer & Poon, 2001; Meyer et al., 2011; Raphael & Kirschner, 1985; Williams, Stafford, Lauer, Hall, & Pollini, 2009). The text structure sentence stems allow the students to precisely summarize and recall key ideas (Meyer & Ray, 2017). Subsequently, students' reading comprehension improves.

Although there is evidence that the TSM can promote reading comprehension (Hebert, Bohaty, Nelson, & Brown, 2016), there is little empirical research reporting results on specific reading processes or investigating the readers' transformation of reading strategies. Recently, researchers have tended to examine cognitive and

metacognitive thinking processes during reading, and they found that the frequency of using metacognitive strategies may explain individual differences in both L1 and L2 reading comprehension (Bergey, Deacon, & Parrila, 2017; Fitrisia, Tan, & Yusuf, 2015; Kolić-Vehovec & Bajšanski, 2006; Mokhtari & Reichard, 2002). As the TSS intervention has been shown to be effective in helping students capture the connections between ideas, students may be more inclined to engage in effortful thinking (employing more higher-level reading strategies) to improve their higher-order comprehension skills (Meyer & Ray, 2017; Perfetti et al., 2005).

My hypothesis for the current study is that the ability to identify text structure and understand connections between key ideas helps students employ more reading strategies, therefore facilitating them to summarize the main ideas of the text. Furthermore, due to the transformation of higher-level reading strategies, readers are more capable of integrating meaning into a mental model of the text, improving their higher-order comprehension skills, and ultimately enhancing their overall reading comprehension. Although vocabulary is important in reading (Perfetti & Stafura, 2014), the TSS approach may have a greater influence on the readers' higher-order comprehension processes through the transformation of higher-level reading strategies. For example, after identifying the signaling words (e.g., *as opposed to*) and then confirming the comparison structure of a passage, students may tend to use a prediction strategy to set expectations before continuing to read. I anticipate that after the ITSS intervention, readers will employ more structure-related and metacognitive strategies during reading, improving their

higher-order comprehension skills and eventually enhancing their overall reading comprehension.

Synthesis of the Research about Reading Comprehension for Chinese ELLs

Understanding the underlying reasons for reading comprehension difficulties is of critical importance for researchers and educators since one of the ultimate goals of literacy instruction is to help people comprehend readings across cultures. Screening for reading problems and monitoring progress are the first recommendations given to English language instructors for ELLs by What Works Clearinghouse (Gersten et al., 2007). Although the topic is important, it was extremely difficult to identify a large number of relevant studies about Chinese ELLs' challenges in learning English as a foreign language. One reason for this dearth of literature might be that even though there is a large population of Chinese ELLs around the world, the population is under-researched in the field (Lau & Chan, 2003). Another reason is that establishing the causes of reading comprehension difficulties can be done only in longitudinal studies, intervention studies, and reading-age-match comparisons (Li & Kirby, 2014), which are difficult to conduct. Most of the relevant studies, however, are correlational studies, from which we can get preliminary relationships between the strategies and outcomes related to the challenges and difficulties the Chinese ELLs face, but the correlational studies do not allow any causal conclusions to be drawn.

L1 (Chinese) reading difficulties for Chinese readers. Reading different languages presents different cognitive demands (Wang, Perfetti, & Liu, 2005). Previous research indicated that Chinese, a logographic system, presents a strong contrast to

alphabetic systems such as English (e.g. Perfetti, 1999; Perfetti et al., 1992). The contrasting characteristics between Chinese and English have caused some variances in how reading works in Chinese compared to in English (Wang et al., 2005; Zhang et al., 2014). For instance, grammatical information is relatively less marked and less explicit in Chinese. That is, the processing of grammar in written Chinese may be more difficult compared to English (Zhang et al., 2014).

Ho and Bryant (1997) demonstrated that an understanding of OPC (orthography-phonology correspondence) is important for Chinese early readers to overcome memory problems in order to read novel characters after an initial phase of learning about 460 Chinese characters. This means if Chinese early readers cannot realize that Chinese characters with identical components may sound the same or similar, it would be difficult for them to differentiate and remember many visually similar Chinese characters and their associated pronunciations. Zhang et al. (2014) also found that poor Chinese comprehenders performed at a lower level than the controls on the morphological compounding task. This effect is especially significant for early Chinese readers. Thus, the morphological compounding task may represent a unique aspect of language comprehension, which is important for integration of Chinese reading, especially for early readers.

Although decoding might be more difficult for Chinese readers, researchers tend to agree that the higher-level processing of reading is a universal cognitive activity independent of the language system (Chen & Juola, 1982; Hung & Tzeng, 1981). Similar cognitive deficiencies have been found in the reading process for poor Chinese readers

compared to poor English readers (Law, 1997). Consistent with the findings in previous studies (Dole et al., 1996; Paris et al., 1994), Lau and Chan (2003) found that poor Chinese readers were less proficient than good readers in recognizing and summarizing main ideas, identifying text structures, detecting errors, and inferring implicit meanings in Chinese texts.

L2 (English) reading difficulties for Chinese ELLs. Compared with their monolingual peers, ELLs encounter more challenges with reading comprehension (August & Shanahan, 2008; Wijekumar et al., 2017). Research indicates that Chinese ELLs might face more difficulties than other ELLs since Chinese is a different language system than an alphabetic language (Koda, 1998; Wang et al., 2005). The first difficulty lies in the vocabulary. Li and Kirby (2014) found that the poor Chinese ELLs performed worse than the average ELLs on vocabulary, which is consistent with the findings of others (Catts, Adlof, & Weismer, 2006; Hock et al., 2009). Vocabulary is a key element to successful reading comprehension, but not the only predictive element (Cain, Oakhill, & Lemmon, 2004). The study by Li and Kirby (2014) also showed that above-average Chinese ELLs performed better on inference and strategy, listening comprehension, and summarizing main ideas than average Chinese ELLs.

When ELLs reach the intermediated and advanced level, it is the higher-level processing skills that differentiate the good readers from the poor readers. The findings of Zhang (2010) indicated that the less successful Chinese ELLs were hindered by a lack of metacognitive strategies that are important to successful reading comprehension.

Traditional English reading instruction for Chinese ELLs centers on grammar instruction based on the word and sentence levels (Li & Li, 2002; Liu, 1995) while neglecting the teaching of those reading strategies (including the metacognitive strategies). Although Chinese ELLs are able to understand individual words and sentences in English, they have difficulties in recognizing text genre, identifying the logical connections within and between paragraphs, and comprehending the main ideas of the text (Yan, 2007).

Recent intervention studies about reading comprehension for Chinese ELLs. ERIC, Academic Search Ultimate, Education Source, and PsycINFO were searched for peer-reviewed articles in the limited years between 2000 and 2019. Search terms included English language learner, learning English as a foreign language or second language, reading, reading comprehension, quantitative or control or quasi-experimental or randomized, etc. (See Figure 1). This search identified 118 articles. After a screening of the abstract and full text, 10 relevant articles were found to be appropriate for the study. In order not to miss important studies related to this topic, I manually searched for the same set of key words on several important journals (i.e., *Scientific Studies of Reading*, *Reading Research Quarterly*, *Computers & Education*, *Journal of Research in Reading*, *British Journal of Educational Technology*, and *Reading and Writing: An Interdisciplinary Journal*), which added three more articles. One was from *Journal of Research in Reading*, one was from *Computers & Education*, and the last was from *Reading and Writing: An Interdisciplinary Journal*.

(Chinese OR China OR Mandarin) AND (english language learner* or ell* or english as a foreign language or efl* or english as a second language or esl or learn* N2 English) AND ((reading N1 comprehension) OR decoding) AND (quantitative OR control OR quasi-experimental OR randomized OR experiment* OR statistic*)

Figure 1. Search Strings. This figure shows the Boolean search strings used in my literature review.

Among the 13 included articles, the most frequently researched topic was instructional method (4 out of 12), followed by strategy training (3), technology (3), and then decoding (3). Most of the Chinese studies were conducted with college-level students (8 out of 12). One reason for this focus may be that it takes many years for Chinese ELLs to learn a foreign language like English. This current study also focused on college-level students for the same reasons. Another area that has been studied with Chinese ELLs is about their use of reading strategies to support their reading comprehension (Li & Li, 2002; Liu, 1995; Zhang, 2010) (for detailed information, see Table 3).

Table 3

Studies about Chinese ELLs' Reading Comprehension

Study	Journal	Age range	n (E/C)	Intervention	Duration	Instrument	Effect size
Chen, Li, & Gui (2018)	*Journal of Education and Training Studies*	College students	87 (43/44)	Instruction on syntactic parsing ability	12 weeks	Reading rate	
Cheung, Mak, Abrami, Wade, & Lysenko. (2016)	*Jl. of Interactive Learning Research*	2nd grade	122 (74/48)	a web-based literacy program	14 weeks	The Group Reading Assessment and Diagnostic Evaluation (GRADE, Williams, 2001)	*d* = 0.33 (phonics), p<0.04
Chow, McBride-Chang, & Cheung (2010)	*Journal of Research in Reading*	Kindergarten	51(17/17/17)	Dialogic reading/typical reading/ control	12 weeks	Receptive vocabulary, word reading, English and Chinese phonological awareness	0.29 (English word reading), 0.36 (English phonological awareness) and 0.28 (Chinese phonological awareness) respectively
Dai & Liu (2012)	*Chinese Journal of Applied Linguistics (Quarterly)*	College students	117 (60/57)	explicit instruction of basic decoding skills	Six weeks	CET_4（listening test)	*d*=0.58, (*p*=0.000< 0.05)

(continued)

Table 3 continued

Study	Journal	Age range	n (E/C)	Intervention	Duration	Instrument	Effect size
Jiang (2015)	*English Language Teaching*	College students	29 (15/14)	Silent reading/ loud-reading	16 weeks	English Major Grade 4	3.61 (p=0. 000< 0.05)
Kao, Tsai, Liu, & Yang (2016)	*Computers & Education*	Fourth-grade students	40 (20/20)	Highly-interactive/ low interactive electronic books	30 mins	the Reading Motivation Questionnaire for e-book; researcher-designed comprehension test and chromatic concept test	d = 1.34 for reading motivation and d =1.22 for story comprehension
Lee, Lee, Liao, & Wang (2015)	*Perceptual & Motor Skills: Perception*	College students	177 (83/94)	Audio-visual aids	Four weeks	Researcher-designed test	d = 0.11 (p= 0.46> 0.05)
Nayak & Sylva (2013)	*The Language Learning Journal*	Aged 9-10	205 (70/67/ 68)	guided reading intervention and the e-book reading	35 mins weekly (duration not specified)	The Neale Analysis of Reading Ability (NARA II),	d= 0.33, p<0.0 5 (guided reading vs. control group on reading comprehension)
Pei (2014)	*Journal of Language Teaching and Research*	College students	66 (36/30)	Metacognitive strategies training	Eight weeks (15 mins per week)	CET_4	-0.19 (p=0. 16)

(continued)

Table 3 continued

Study	Journal	Age range	n (E/C)	Intervention	Duration	Instrument	Effect size
Tian & Macaro (2012)	*Language Teaching Research*	College students	117(40/40/37)	lexical Focus-on-Form treatment (codeswitching/English-only)	Duration not specified (additional 1.5 hours per week)	Researcher-designed	d=1.84, p<0.001
Wang, Lawson, & Curtis, 2015	*Language Teaching Research*	College students	98 (three groups)	a control group, a nonconstrained imagery group and a constrained imagery group	Four weeks	Massachusetts Comprehensive Assessment System (MCAS) English Language Arts test	
Yang (2017)	*English Language Teaching*	College students	110	Strategy training	Five weeks	Objective test	0.30 (p-value not available)

(continued)

Table 3 continued

Study	Journal	**Age range**	**n (E/C)**	**Intervention**	**Duration**	**Instrument**	**Effect size**
Yeung, Siegel, & Chan (2013)	*Reading and Writing: An Interdisciplinary Journal*	Kindergarten	76 (38/38)	language-enriched phonological awareness instruction	12 weeks	receptive and expressive vocabulary, phonological awareness at the syllable, rhyme and phoneme levels, reading, and spelling in English	phonological awareness at all levels: partial $\eta 2 = 0.42$; English word reading, Cohen's $d = 0.23$; English word spelling, Cohen-$d = 0.55$

Regrettably, most of the studies did not provide a strong theoretical foundation and detailed information about the study design. For example, the papers did not provide details regarding the interventions (e.g., Jiang, 2015—silent reading and loud mode; Tian & Macaro, 2012— lexical Focus-on-Form treatment) and students' English reading comprehension outcomes (e.g., Jiang, 2015—general English competence including vocabulary, reading comprehension, listening comprehension, and writing; Tian & Macaro, 2012—vocabulary learning). Due to the paucity of randomized controlled studies

and lack of information about the interventions, no definitive causal conclusions can be drawn from those studies.

Only three studies provided detailed information about the study design. One was about the effect of parent-child reading interaction patterns on kindergarten children's English reading comprehension (Chow, Chang, & Cheung, 2010). The study showed that parent–child reading could improve children's English word reading skills (d= 0.29), while dialogic reading could promote phonological awareness in both Chinese (d=0.28) and English (d=0.36). The other study was interested in investigating the effect of low/high interactive electronic picture books on fourth-grade students' reading motivation and English reading comprehension (Kao, Tsai, Liu, & Yang, 2016). Findings indicated that the high interaction group performed significantly better in reading motivation (d= 1.34) and story comprehension (d= 1.22) than the low interaction group. Another study attempted to examine the effects of phonological awareness instruction on kindergarten children's English reading comprehension (Yeung, Siegel, & Chan, 2013). This study found that children receiving the phonological awareness instruction scored significantly higher than the comparison group on English word reading (d= 0.23) on the post-test when statistically controlling for age, general intelligence, and the pretest scores.

Since all of the studies were performed at low grade levels, none of the three high-quality studies addressed the issue of the metacognitive reading strategies to support reading comprehension (Yan, 2017; Zhang, 2010). Furthermore, all of the three studies targeted early-age Chinese ELLs, and none of them focused on adult Chinese ELLs' reading comprehension improvement. Therefore, I sought to extend the application of the

TSS (through ITSS) with strong empirical and theoretical foundations to college level Chinese ELLs to study the effects of this type of reading comprehension strategy training on students' reading strategies change and reading comprehension outcomes with reliable and valid measures.

Reading strategies transformation. Another focus of the current study was the effect of the TSS on higher-order comprehension skills. Theories of multi-level reading comprehension classify comprehension tasks into two levels: lower-order and higher-order comprehension skills (Basaraba, et al., 2013; Miller, & Smith, 1985; Perfetti et al., 2005; Van Kleeck, Vander Woude, & Hammett, 2006). Lower-order comprehension skills refer to literal comprehension. For literal comprehension tasks, readers retrieve information directly stated in a passage, which mainly relies on word-level processing skills. Higher-order comprehension skills refer to inferential comprehension and evaluative comprehension skills. Inferential comprehension tasks require readers to read between the lines and make inferences about implicit meanings of the text, such as the author's intended message and omitted details. In evaluative comprehension tasks, readers critically analyze and evaluate the information in the text in connection to their prior knowledge or knowledge from outside of the text. Inferential and evaluative comprehension skills require higher-level reading strategies such as divergent thinking, critical analysis, synthesis, evaluation, and affective or personal response to the text (Basaraba et al., 2013; Van Kleeck et al., 2006). These low-order (literal) and higher-order reading skills (inferential and evaluative) interact with each other and facilitate the development of reading comprehension (Dole, Duffy, Roehler, & Pearson, 1991; Kintsch

& Rawson, 2005). Each of the three tasks—literal comprehension, inferential comprehension, and evaluative comprehension skills—plays a critical role in comprehending the text.

Previous studies about the TSS or ITSS proved that the instruction is effective in improving students' overall reading comprehension skills (e.g., Meyer, 1975; Wijekumar, Meyer, & Lei, 2012, 2017; Williams et al., 2004). To date, no intervention studies have been identified to investigate the effect of TSS instruction on adult Chinese ELLs' reading comprehension, especially on their use of reading strategy. The current study attempted to use the ITSS to investigate if the TSS is effective in altering adult Chinese ELLs' reading strategies, therefore having a greater influence on their higher-order comprehension skills.

Why intelligent tutoring for structure strategy (ITSS). The TSS is an effective reading strategy that helps readers focus on seeking coherence through the top-down process of connecting ideas using five text structures. Multiple studies have shown that the TSS is effective in improving comprehension outcomes for readers of various age groups, such as primary and middle graders, college students, and older adults (e.g., Meyer, 1975; Wijekumar, Meyer, & Lei, 2012, 2017; Williams et al., 2004). There are also positive effects of human tutors training students to use the TSS (Bartlett, 1978; Carrell, 1985; Cook & Mayer 1988; Polley, 1994). However, training large numbers of human tutors is financially and practically not feasible, especially in the context of China. The intelligent tutoring for the structure strategy (ITSS) system was found to be a solution to these challenges, which could replace human tutors to provide consistent and accessible instruction to students based on the prevalence of computers and improved internet

connectivity in schools (Wijekumar & Meyer, 2006; Xu, Wijekumar, Ramirez, Hu, & Irey, 2019).

The priority of ITSS was to build a learning environment that was motivating, easily accessible, and interactive (Meyer & Wijekumar, 2007). ITSS uses texts from science, social studies, current events, and sports to teach students how to use the TSS in their reading. ITSS mainly contains the following four activities for learners: 1) identify the signaling words; 2) classify the text structure; 3) write the text's main idea while being able to view the passage; and 4) recall the information of the passage by using the main idea as a guide (Wijekumar et al., 2012).

ITSS is designed specifically to minimize distracting details and make learners focus on the text and the instruction (Wijekumar et al., 2013). For example, ITSS uses a book-like interface shown in Figure 2. At every session, each student logs into his or her own ITSS account. The system uses an animated pedagogical agent named I.T. (Intelligent Tutor) to present the instruction to learners. First, I.T. informs the student of the objectives of the session (e.g., "Today we are going to learn about the cause and effect text structure") and models how he/she would finish the task (e.g., "When I read a passage I look for signaling words"). Then, I.T. continues to read the passage, highlights the signaling words, and asks the student to practice identifying the signaling words from another similar passage. When the student has answered his/her questions, I.T. processes the student responses and checks the answers against the database. I.T. then provides individualized assessment and feedback to the students (e.g., "Excellent job!" or "Please correct your signaling words"). Students are then required to identify the text structure of the passage.

After this step, students are asked to write a main idea guided by the pattern for the text structure. Finally, students are asked to recall the passage from memory. In the whole process, students interact with ITSS at their own pace, listening to the I.T., writing their answers, and getting feedback and help when necessary from pop-up windows.

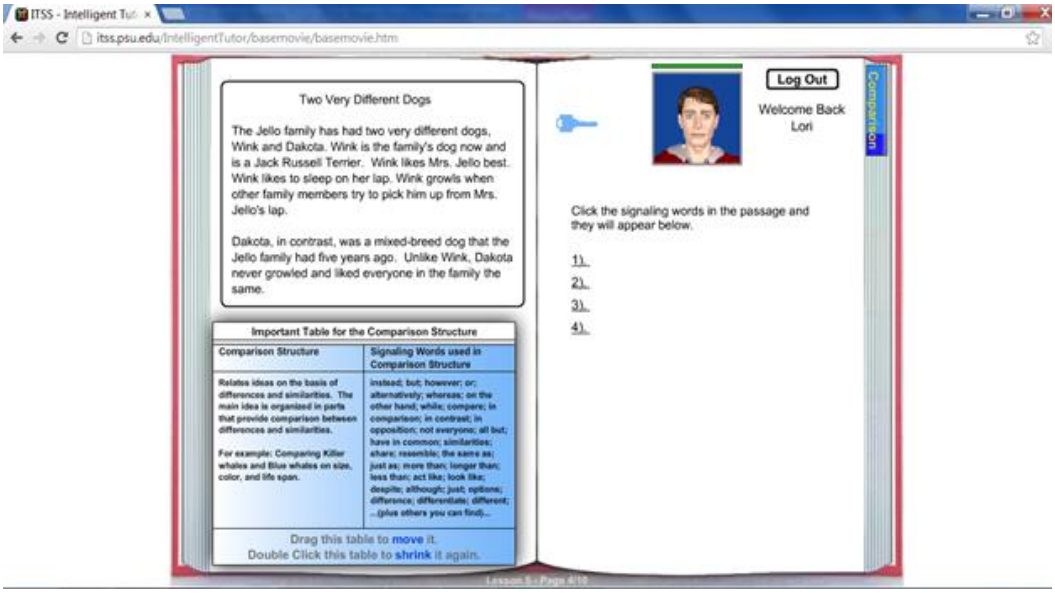

Figure 2. ITSS Interface. This is the interface for the ITSS system.

To date, ITSS has mainly been used in randomized controlled studies with monolingual English speakers at the elementary and middle-grade levels (Meyer et al., 2010; Wijekumar, Meyer, & Lei, 2012, 2017; Wijekumar et al., 2017). Most recently, the new generation of ITSS, referred to as SWELL (a similar system to ITSS), has shown promise for Spanish speaking ELLs in upper elementary grade levels (Wijekumar et al.,

2017). All studies present evidence that ITSS and SWELL were effective in improving students' reading comprehension outcomes measured by standardized and researcher-designed measures. No studies have been conducted to examine the effects of ITSS on adult Chinese speaking ELLs' reading comprehension. Furthermore, although previous empirical evidence suggests that ITSS positively affects reading comprehension as measured by tests, those tests do not provide enough evidence to determine how students' reading comprehension improves. The current study attempted to explore whether students' reading strategies altered through the use of ITSS and whether there was a mediating effect between the change in students' reading strategies and their reading comprehension.

Pilot Study

In the spring semester of 2018, I conducted a pilot study on the effect of ITSS on adult Chinese ELLs' reading comprehension in a university located in the Southwest part of China to test my hypothesis. Two classes in the Department of English with a total of 61 students were chosen to participate in this study. Students from both classes had the same majors, similar age ranges (aged 18-20) and equal prior language proficiency. The experimental group included four males and 27 females, a total of 31 students, and the comparison group included five males and 25 females, a total of 30 students. All participants had studied English for at least six years before college. I administered pre- and post-tests before and after the intervention to measure students' reading

comprehension. I also employed thinking-aloud protocols[1] to find out whether the students' reading strategies changed after the use of ITSS.

Summarized results of the pilot study. The students in the experimental and comparison groups were statistically equivalent on their initial English reading skills [t (59) = 1.45, $p > 0.05$]. However, the students in the ITSS experimental group had higher TOEFL (Test of English as a Foreign Language) reading post-test scores than the students in the comparison group. The students' post-test reading scores (i.e., overall TOEFL reading test scores and three TOEFL sub-reading test scores) are reported in Table 4. The results of multiple regression showed that ITSS intervention significantly predicted students' overall TOEFL reading scores (Table 5). Specifically, students in the experimental group scored 3.22 units higher on the overall TOEFL reading test after receiving the ITSS intervention ($\beta = 3.22$, $p < 0.05$) than the comparison group students, which indicated a medium intervention effect with Cohen's $d = 0.67$. I also found that ITSS intervention was only a significant predictor for inferential ($\beta = 0.91$, $p < 0.05$, Cohen's $d = 0.59$) and evaluative ($\beta = 1.06$, $p < 0.05$, Cohen's $d = 0.61$) subskills but not for literal subskills ($\beta = 1.25$, $p > 0.05$) (see Table 6).

[1] Think-aloud is an effective research tool where the researcher asks the readers to externalize their internal reading practices and make their thoughts audible (Afflerbach & Johnston, 1984; Berne, 2004; Kucan & Beck, 1997; Olson, Duffy, & Mack, 2018).

Table 4

Overall TOEFL Reading Score and Three TOEFL Reading-Subskill Scores by the Intervention Condition (Pilot Study)

Intervention condition	*N*	TOEFL	TOEFL - Literal	TOEFL - Inferential	TOEFL - Evaluative
		M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)
T = 0	31	23.73 (5.54)	14.20 (3.22)	5.67 (1.77)	3.87 (1.76)
T = 1	30	26.03 (5.23)	14.96 (2.95)	6.39 (1.45)	4.68 (1.92)

Table 5

Multiple Regression Analysis Results (Pilot Study)

	Estimate	Standard Error	*t*-value	*p-value*	*Cohen's d*
Intercept	6.67	4.37	1.53	0.1320	
CET-4	1.29	0.32	3.99	0.0001***	
ITSS Intervention	3.22	1.26	2.57	0.0126*	0.67

** indicates p<0.05; ***indicates p<0.001.*

Table 6

Multivariate Regression Analysis Results (Pilot Study)

	Estimate	Standard Error	*t*-value	*p-value*
Literal Subskill				
Intercept	5.32	2.56	2.08	0.04
CET-4	0.67	0.19	3.54	0.00***
ITSS Intervention	1.25	0.74	1.70	0.09
Inferential Subskill				
Intercept	2.12	1.40	1.52	0.13
CET-4	0.27	0.40	2.58	0.01*
ITSS Intervention	0.91	0.10	2.27	0.03*
Evaluative Subskill				
Intercept	-0.78	1.57	-0.49	0.62
CET-4	0.35	0.12	3.03	0.00**
ITSS Intervention	1.06	0.45	2.36	0.02*

* indicates $p<0.05$; **indicates $p<0.01$; ***indicates $p<0.001$.

Via the think-aloud protocols, I found that there was no significant difference between the ITSS intervention group and the comparison group for all three categories of reading strategies as well as the total frequency of strategy use in the pretest. However, for the post-test think-aloud activity, students in the intervention group outperformed students in the comparison group on structure-related reading strategies (t =3.26, p=.005<.01), metacognitive strategies (t= 3.65, p=.002<.01), and the total frequency of strategies used (t= 3.60, p=.002<.01), but the intervention group did not outperform on

literal strategies (t = 1.67, p =.11>.05). Furthermore, in the ITSS intervention group, the percentage of students using metacognitive strategies increased from 31.97% in the pretest to 50.18% in the post-test (see Table 7 and 8).

Table 7

Frequency and Percentage (Frequency/Total) of Strategy Use (Pilot Study)

	ITSS (*N* = 9)				Comparison (*N* = 9)			
	Pretest		Post-test		Pretest		Post-test	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Literal strategy	11.78	6.55	12.44	3.64	10.22	4.63	14.89	2.47
Literal strategy percentage	41.34%	0.11	32.80%	0.10	40.40%	0.16	54.75%	0.11
SS strategy frequency	6.56	2.51	6.56	3.05	4.22	2.64	2.67	1.87
SS strategy frequency percentage	26.69%	0.10	17.03%	0.08	16.48%	0.11	9.55%	0.06
Metacognitive strategy frequency	9.78	8.53	19.78	6.92	11.33	5.55	10.22	3.70
Metacognitive strategy percentage	31.97%	0.12	50.18%	0.09	43.12%	0.08	35.70%	0.09
Total strategy frequency	28.11	15.52	38.78	7.89	25.78	10.57	27.78	4.68

Table 8

Comparision of Frequency of Strategy Use in Pretest and Post-test (Pilot Study)

		ITSS		Comparison			
		M	*SD*	*M*	*SD*	*t* values	*p* values
Pretest	Literal	11.78	6.55	10.22	4.63	0.5835	0.5677
	SS	6.56	2.51	4.22	2.64	1.9271	0.0719
	Meta	9.78	8.53	11.33	5.55	0.6539	0.4569
	Total	28.11	15.52	25.78	10.57	0.3723	0.7146
Post-test	Literal	12.44	3.64	14.89	2.47	1.6709	0.1142
	SS	6.56	3.05	2.67	1.87	3.2619	0.0049**
	Meta	19.78	6.92	10.22	3.70	3.6549	0.0021**
	Total	38.78	7.89	27.78	4.68	3.5973	0.0024**

**$p<0.01$.

This pilot study confirmed my hypothesis that the ITSS intervention positively affected Chinese ELLs' reading comprehension. Specifically, the ITSS had a positive effect on adult Chinese ELLs' higher-order comprehension skills. Furthermore, the ITSS contributed to the Chinese ELLs' increased use of metacognitive and text structure-related strategies.

Limitations of the pilot study. Though the hypothesis was confirmed, this pilot study had some limitations. First, my small sample size limited my ability to analyze the mediation effect between the ITSS intervention and reading comprehension through the transformation of reading strategies, which was the major focus of the study. Second, the sample was not a typical population of ELLs in China. The participants in this study were all English majors, who might have different profiles from the typical ELLs in China.

Third, the study design had some drawbacks. For instance, I used two different tests for pretest (CET-4, College English Test-4) and post-test (TOEFL), considering the students' appropriate language proficiency. However, using different tests for the pre- and post-tests limited the validity of the study. Therefore, I decided to conduct a more comprehensive study and recruit a bigger sample size to replicate what I found in the pilot study.

Research Questions

1. Is ITSS more effective in improving adult Chinese ELLs' overall reading comprehension skills (overall CET-4 score) than traditional instruction used by Chinese instructors after controlling for prior English language proficiency (pre-CET-4 score)?
2. Is ITSS more effective in improving adult Chinese ELLs' higher-order reading comprehension skills (higher-order CET-4 score) than traditional instruction used by Chinese instructors after controlling for prior English language proficiency (pre-CET-4 score)?
3. Do Chinese ELLs using ITSS report employing more reading strategies in the post-survey of reading strategies—metacognitive (e.g., prediction and inference making), literal (e.g., paraphrasing and guessing a word meaning) and text structure-related reading strategies (signaling words, summarizing, and text structure)—than ELLs who receive traditional instruction after controlling for prior English language proficiency (pre-CET-4 score)?

4. To what extent does the use of reading strategies mediate the relationship between the intervention/control condition and Chinese ELLs' reading comprehension controlling for prior English language proficiency (pre-CET-4 score)?

CHAPTER III

METHODS

Research Design

The current study applied a quasi-experimental nonequivalent control group design. Random assignment in this study was difficult due to two practical reasons. First, it was impossible to divide students in the same class into different intervention conditions. Second, it was difficult to disrupt the university's schedule and ask for an extended period of time to assign students randomly into intervention conditions.

In this study, I randomly selected two intact classes from my sample as the experimental group (Research Condition $T = 1$) and the other two classes taught by the same instructor as the comparison group (Research Condition $T = 0$). The experimental and comparison groups used the same curriculum taught by the same instructor. I chose four classes that all had the same instructor to control the effects of teachers because research indicated that teachers play a critical role in students' achievement (National Commission on Teaching and America's Future, 1996; Darling-Hammond, 2000). Using the same instructor for the experimental and comparison group reduced the teacher's effects to a minimum. For the experimental group, one of the English classes was substituted by ITSS instruction (40 minutes) each week for 10 weeks while the comparison group continued their regular English class with traditional instruction. Table 9 and Table 10 show the consistency in curriculum and instructional time between these two classes.

Table 9

Courses Taken and Textbooks Used by Experimental and Comparison Group

Courses taken by both groups (Semester 1)	Textbooks used by both groups
Intensive Reading(II)	New Horizon College English 2—Reading and Writing (Zhen Shutang, Yi Meiwen, 2015)
English Listening (II)	New Horizon College English 2—Viewing, Listening and speaking (Zhen Shutang, Jin Xia, 2016)
English Speaking (II)	New Inside Out 2—Intermediate Student's Book (Sue Kay & Vaughan Jones, 2012)
News Listening	Listen to News (He Gaoda, Gan Ronghui, 2016)
Courses taken by both groups (Semester 2)	Textbook used by both groups
Intensive Reading(III)	New Horizon College English 3—Reading and Writing (Zhen Shutang, Yi Meiwen, 2015)
English Listening (III)	New Horizon College English 3—Viewing, Listening and speaking (Zhen Shutang, Jin Xia, 2016)
English Speaking (III)	New Inside Out 3—Intermediate Student's Book (Sue Kay & Vaughan Jones,2012)
News Listening	Listen to News (He Gaoda, Gan Ronghui, 2016)

Table 10

Instructional Process in Intensive Reading Class for Experimental and Comparison Group

Instructional Process	Type 1: Lead-in lesson of a new unit	Type 2: New Passage Analysis	Type 3: Exercise Lesson and Review
15 minutes	Warming-up and teacher's introduction to new unit	Warming-up and teacher's introduction to new unit	Warming-up and teacher's introduction to new unit
30 minutes	Group work for new words activity	Text Analyzing: grammar instruction; sentence paraphrase and translation; appreciation of stylistics	Dictation of the new words and focal points in the notebook; exercises checking on the textbook
40 minutes	Experimental Group: ITSS activity Comparison Group: Background information introduction	Experimental Group: ITSS activity Comparison Group: Text Paraphrasing: grammar instruction; sentence paraphrase and translation; appreciation of stylistics	Experimental Group: ITSS activity Comparison Group: Overview of the text and self-checking about the exercise.

Setting

The current study was conducted in a comprehensive university in East China. The students in the experimental group received the ITSS instruction in the computer lab each week for 40 minutes for 10 weeks.

Participants

Four classes in the engineering department with a total of 235 students from a university in East China were chosen to participate in this study. Even though students from the four classes had different majors, they all had engineering backgrounds and were within similar age ranges (aged 18-20). The experimental group included 78 males and 34 females with a total of 112 students, and the comparison group included 71 males and 52 females with a total of 123 students. All participants had studied English for at least six years before college. The instructor and the participating students completed their consent forms prior to the start of the study. I used a t-test to compare the students' prior reading abilities in the intervention and comparison groups.

Materials

Materials for this study included the web-based lessons described in Chapter 2 and teacher professional development materials (i.e., PowerPoint description of text structure and sample lessons).

Measures

Reading comprehension outcome measures. The CET- 4 reading section was used in this research for pretest and post-test. The pretest used the reading section of the CET-4 to establish the equivalence for students' prior reading abilities between the intervention and comparison groups. The pretest CET-4 scores were used as a covariate for data analyses when examining the effects of ITSS instruction on my dependent measures, focusing on reading comprehension. The post-test CET-4 scores were the

outcome for the primary research question. I used raw scores for separate (higher/lower-order) comprehension skills and overall comprehension for CET-4.

CET-4. The CET-4 is a nationally standardized English test in China used to examine the English language proficiency of undergraduate students (Zheng & Cheng, 2008). In the current study, I administered the reading section of CET-4 at pre- and post-test.

The reading section of the CET-4 is composed of four passages, with five multiple choice reading comprehension questions for each passage and 20 questions in total and 2 points for each question for a sum total of 40 points. Each passage contains approximately 350 words. The CET-4 has been demonstrated to achieve high validity with the discriminant validity index equaled to 0.82 and the criterion-related validity index equaled to 0.7 (Yang, 2000), as well as high reliability with the internal consistency reliability at Cronbach's Alpha 0.9 (Yang and Weir, 1998).

Higher-order and lower-order reading comprehension scores. I coded the items of reading comprehension tests to higher-order comprehension skills and lower-order comprehension skills. Following the approach used by Basaraba et al. (2013) and Van Kleeck et al. (2006), each question of the CET-4 reading sections was coded for the level of reading comprehension assessed by two independent coders. Questions that targeted word-level or sentence-level comprehension were coded as literal comprehension (lower-order comprehension). Examples of questions included word meaning and understanding of a specific sentence. Questions that required readers to infer the answer from multiple sentences (inferential comprehension) or that needed synthesis, such as

summarizing the main idea and identifying the organization of the paragraph(s) (evaluative comprehension), were coded as higher-order comprehension. I used raw scores for separate (higher/lower-order) comprehension skills. For instance, in the pretest CET-4, 12 out of 20 items were coded as questions that were assessing students' literal reading comprehension skills. Therefore, 24 out of 40 points were measuring students' lower-order comprehension skills, while 16 points were measuring the students' higher-order comprehension skills. Sample questions for each level of comprehension and the corresponding items for each level are presented in Table 11. The initial coding had 94.6% agreement, and the two coders reached 100% agreement after discussion.

Table 11

Example Questions of Levels of Comprehension in the Pre- and Post-test

Levels of comprehension	Levels of comprehension	Definition	Example question	Items corresponding to each level
Lower-order comprehension skills	Literal	The answer is explicitly stated in the passage.	"…old is suddenly in" (Line 1, Para. 1) most probably means "____".	CET-4 pretest: 22, 23, 24, 26, 28, 29, 32, 34, 36, 38, 39, 40 CET-4 post-test: 21, 24, 27, 28, 29, 32, 33, 34, 36, 37, 39
Higher-order comprehension skills	Inferential	The answer is implicitly stated in the passage, and the reader needs to make inferences about the intended messages from multiple sentences.	It can be inferred from the passage that____.	The rest items are corresponding to higher-order comprehension skills.
	Evaluative	The reader needs to synthesize information in the passage to answer the question.	What is the author's attitude toward the future of autos?	

Reading strategies outcome measures—*SORS*. The adapted form of the survey of reading strategies (SORS, Mokhtari & Reichard, 2002) was used to assess Chinese adult ELLs' transformation of reading strategies through the use of the ITSS. The SORS is

based on the Metacognitive-Awareness-of-Reading-Strategies Inventory (MARSI), which is a tool for measuring native English-speaking students' awareness and perceived use of reading strategies during reading (Mokhtari & Reichard, 2002). Cronbach's Alpha for the overall scale is high (α = .93). The SORS was developed to measure adolescent and adult ELLs' awareness and perceived use of reading strategies during reading (Mokhtari & Sheorey, 2002). I adapted the SORS according to our research questions. I defined literal reading strategies, such as going back and forth in the text to connect ideas, guessing the meaning of unknown words by recalling the meaning of a seemingly familiar word, and paraphrasing/translating, as lower-level reading strategies. If the readers were trying to figure out the text structure of the passage, summarize what they read to reflect on important information in the text, or use signaling words to help understand the information when reading, they were categorized as structure-related strategies. If the readers were aware of using metacognitive reading strategies, such as critically analyzing and evaluating the information presented in the text or previewing the text to see what it will be about before reading, I categorized them as metacognitive reading strategies. Both metacognitive and structure-related strategies were coded as higher-level reading strategies, while literal reading strategies were coded as lower-level reading strategies (see Appendix A: The Survey of Reading Strategies).

Table 12

Three Categories of Reading Strategies

	Type of Strategy	Strategies
Lower-level reading strategies	Literal reading strategies	I go back and forth in the text to connect ideas.
		I try to guess the meaning of unknown words or phrases by recalling the meaning of a seemingly familiar word , or by analyzing a word in itself (prefix, root and suffix)
		I paraphrase/ restate ideas in my own words to better understand what I read./ When reading the text, I translate the sentences from English to Chinese.
		I reread to increase my understanding when reading.
Higher-level reading strategies	Structure-related Strategies	I try to figure out (decide) the text structure of the passage or paragraph when reading.
		I summarize what I read to reflect on important information in the text.
		I use signaling words to help me understand the information when reading.
	Metacognitive reading strategies	I check to see if my guesses about the text are right or wrong
		I use context clues to help me better understand what I read.
		I decide what to read closely and what to ignore (e.g., I skip irrelevant or unimportant words or sentences).
		I critically analyze and evaluate the information presented in the text.
		I skim the text first by noting characteristics such as length.
		I preview the text to see what it is about before reading.
		I try to guess what the material is about when I read.
		I correct or change an idea formed earlier in my reading.
		I ask questions about the text.
		I elaborate, interpret, or reason with or about a focal segment; bring new information to the focal segment, including relating it to prior knowledge or information in other information segments.
		I skim through the text and decide the purpose of reading
		I use typographical aids such as bold face and italics to identify key information (including tables).

Note. Adapted from Sheorey and Mokhtari's Survey of Reading Strategies (2001)

Procedure

Students were provided with the informed consent forms prior to the beginning of the study. The instructor received four hours of professional development about the TSS and web-based ITSS prior to the beginning of the term. Before the intervention, the instructor administered the reading sections of CET-4 to both groups during March 2019 in a quiet classroom to compare the participants' prior English reading ability. After the pretest, the students in both groups were required to complete the survey of reading strategies.

Students in the experimental group used ITSS for one session a week for 40 minutes over 10 weeks (March 2019 to June 2019) as a partial substitute for the English curriculum. At each session of the current study, each student opened a browser and logged into their ITSS account. The students interacted with the program at their own pace, listening to an animated pedagogical agent (I.T.), writing their answers, and getting feedback and help when necessary through pop-up windows. At the conclusion of the class period, the system saved their lesson and page number for use at the next session. ITSS would monitor the students' usage every week. If there was any violation to the 40 minutes per week intervention for 10 weeks, I notified the instructor and the respective student to keep the planned intervention on track.

To evaluate the students' reading comprehension after the intervention, students in both groups were administered the reading sections of CET-4 at the end of the school semester (June 2019) under the same conditions as the pretest. All of the participants also completed the survey of reading strategies after the post-test.

Data Analysis

To investigate the equivalence in the initial English reading abilities of students across the experimental and comparison groups, I employed the independent samples *t*-test for the CET-4 reading pretest scores.

To examine the overall effects of ITSS on adult Chinese ELLs' reading comprehension (the first research question), two multiple regressions were analyzed with the CET-4 post-test scores as the dependent variable and the ITSS intervention condition (T) as the independent variable, with CET-4 pretest scores as covariates. A least-squares estimation was used to determine the regression coefficient parameters in the multiple regressions.

To answer the second research question, a multivariate multiple regression was employed to test the impact of ITSS intervention on the higher-order and lower-order comprehension skills of adult Chinese ELLs. The two correlated subskill post-test scores were used as dependent variables. The ITSS intervention condition (T) and the higher-order and the lower-order comprehension score of the pretest CET-4 were used as independent variables. The least-squares estimation was utilized as the parameter estimation method.

To answer the third research question, I employed several paired sample t-tests to investigate if the students in the experimental group used more reading strategies than the students in the comparison group used.

To answer the last research question, a multiple regression was conducted with the CET-4 overall reading post-test scores as the dependent variable, the ITSS intervention

condition (T) and CET-4 reading pretest scores as independent variables, and the reading strategy scores as the mediator. The least-squares estimation was used to estimate the regression coefficient parameters in the multiple regression.

CHAPTER IV

RESULTS

Two hundred thirty-five first-year undergraduates signed the consent form. Two hundred and seven students completed all of the intervention (experimental group) or traditional instruction (comparison group) for 10 sessions, filled out the reading strategies pre and post survey, and finished the CET-4 pretest and post-test. One hundred and two students were in the experimental group, and 105 were in the comparison group. Due to the differential amounts of missing data by outcome variables, missing data were deleted during analysis for each model to maximize the usage of available data for each outcome.

The two research condition groups were taught by the same instructor. Thus, the major difference between the groups was related to the use of ITSS for 40 minutes each week as a supplement to the curriculum. The regular curriculum consisted of 85 minutes of traditional instruction on English reading such as text paraphrasing, grammar instruction, introduction of new words, and text analysis, etc. following textbooks such as *New Horizon College English 2—Reading and Writing*, *New Inside Out 2—Intermediate Student's Book*, and *Listen to News*.

Among the participants, 60.87% (n=126) were males and 39.13% (n=81) were females. They were all in the first year of their college education and had learned English for at least six years.

The reliability score of CET-4 in this administration was acceptable (α = 0.73), especially if the number of items in the test as a factor are considered. Since I administered fewer question items to students, this would affect the reliability score of the test.

According to the literature, CET-4's reliability score could reach 0.9 for the whole set of test questions. Because my primary goal was to measure students' reading comprehension improvement, I only administered the reading section (20 question items) of CET-4 (total question items=55, not including writing and translation) to the students.

Participants' Initial English Reading Ability

To investigate the equivalence in initial English reading abilities of students across the experimental and comparison groups, I employed the independent samples *t*-test for CET-4 reading test scores in the pretest. Results showed that there was statistical significance between the experimental group and comparison group [t (206) = 3.37, p < 0.001]. The students in the experimental group had lower CET-4 reading scores (M = 19.24, SD = 0.66) than the students in the comparison group (M = 22.34, SD = 0.63) in the pretest, indicating that students in the two groups were not equivalent on their initial English reading skills. Thus, I used students' pretest scores as a covariate in the rest of the data analysis. (See Table 13).

Table 13

Independent Samples T-test of Pre CET-4 Reading Test Between the Experimental Group and the Comparison Group

Intervention condition	*n*	M (SD)	*t*-value	Degree of freedom	*p-value*
T = 0	105	22.34 (0.63)	3.37	205	0.0009***
T = 1	102	19.25 (0.67)			

*Note. *** p<0.001*

Research Question 1

The first research question was "Is ITSS more effective in improving adult Chinese ELLs' overall reading comprehension skills (overall CET-4 score) than traditional instruction used by Chinese instructors after controlling for prior English language proficiency (pre-CET-4 score)?" The students in the ITSS experimental group had higher post CET-4 reading test scores than the students in the comparison group even though their pretest scores were lower than the scores in the comparison group. The students' post-test reading scores (i.e., overall CET-4 reading test scores and two sub-reading test scores) are reported in Table 14. Figure 3 also describes the post-test comparison between the experimental group and comparison group.

Table 14

Overall Post CET-4 Reading Score and Two Sub-reading Skill Scores by the Intervention Condition

Intervention condition	*n*	Post CET-4	Post CET-4 Higher reading comprehension	Post CET-4 Lower reading comprehension
		M (*SD*)	M (*SD*)	M (*SD*)
T = 0	105	26.13 (7.06)	11.85 (3.98)	14.27 (4.17)
T = 1	102	27.61 (7.16)	13.04 (3.49)	14.71 (4.71)

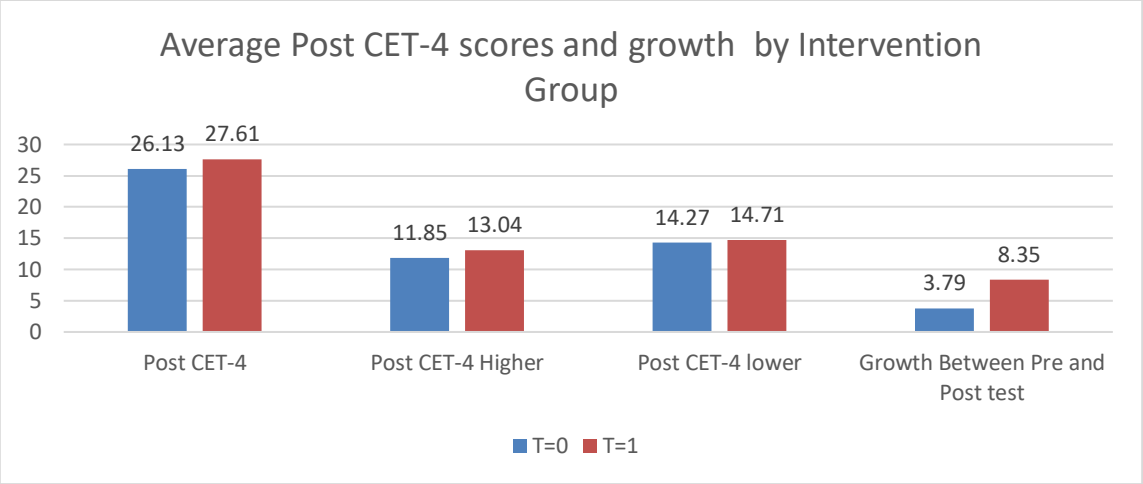

Figure 3. The Post CET-4 Scores (Overall, Higher-order, Lower-order Mean, and Growth Gain) for Both Experimental and Comparison Groups

To answer the first research question and examine the effect of ITSS on adult Chinese ELLs' overall reading comprehension, a multiple regression was computed to predict the post-CET-4 reading score based on the ITSS intervention condition (T) and pre-CET-4 reading test scores. Pre-CET-4 reading test scores were included in this model to control for the effect of prior English reading comprehension abilities on the outcome. The least-squares estimation was used to estimate the regression coefficient parameters in the multiple regression.

The results of the multiple regression showed that both ITSS intervention and pre-CET-4 scores were significant predictors of students' overall post-CET-4 reading scores (Table 15). A significant regression equation was found (F (2, 204) =31.63, $p < .000$), with an R^2 of 0.237. Specifically, students in the experimental group scored 3.07 units higher

on the post CET-4 reading test after receiving the ITSS intervention ($\beta = 3.07$, $p < 0.001$) than the comparison group students with Cohen's $d = 0.43$.

Table 15

Multiple Regression Analysis Results

	Estimate	Standard Error	*t*-value	*p-value*	*Cohen's d*
Intercept	14.62	1.60	9.12		
CET-4	0.52	0.07	7.77	0.001***	
ITSS Intervention	3.07	0.89	3.43	<0.001***	0.43

*Note. *** p<0.001.*

Research Question 2

The second research question was "Is ITSS more effective in improving adult Chinese ELLs' higher-order reading comprehension skills (higher-order CET-4 score) than traditional instruction used by Chinese instructors after controlling for prior English language proficiency (pre-CET-4 score)?"

To answer the second research question, a multivariate multiple regression was employed, in which the ITSS intervention condition and pre-CET-4 reading scores were used as independent variables, and the two sub-reading skills test scores were used as dependent variables. The multivariate regression was chosen because higher-order and lower-order reading skills test scores were highly correlated with each other (the Pearson correlation coefficient between higher-order and lower-order sub-reading skills test scores was 0.49 ($p < 0.001$)).

As shown in Table 16, ITSS was more effective in improving adult Chinese ELLs' higher-order reading comprehension skills than traditional instruction controlling for English language proficiency (p<0.001, Cohen's d = 0.49). ITSS was also shown to be effective in improving students' lower-order reading comprehension skills (p<0.05, Cohen's d = 0.25).

Table 16

Multivariate Regression Analysis Results

	Estimate	Standard Error	*t*-value	*p-value*
Higher-order reading comprehension skills				
Intercept	6.74	0.87	7.72	
Pre CET-4 Higher	0.32	0.10	3.33	0.001***
Pre CET-4 Lower	0.17	0.06	2.84	0.005**
ITSS Intervention	1.89	0.49	3.85	<0.001***
Lower-order reading comprehension skills				
Intercept	7.90	1.03	7.69	
Pre CET-4 Higher	0.42	0.11	3.67	<0.001***
Pre CET-4 Lower	0.21	0.07	2.90	0.004**
ITSS Intervention	1.29	0.58	2.23	0.027*

Note. * p<0.05; ** p<0.01; *** p<0.001.

Research Question 3

The third research question was "Do Chinese ELLs using ITSS report employing more reading strategies in the post-survey of reading strategies—metacognitive (e.g., prediction and inference making), literal (e.g., paraphrasing and guessing a word meaning)

and text structure-related reading strategies (signaling words, summarizing, and text structure)—than ELLs who receive traditional instruction after controlling for prior English language proficiency (pre-CET-4 score)?"

Generally, the students in the comparison group had higher reading strategy scores than the students in the experimental group. However, the students in the experimental group had more improvement after receiving the ITSS intervention compared with the students in the comparison group who received the traditional instruction. The students' pre- and post-test reading strategy scores (i.e., overall reading strategy scores, higher-order and lower-order strategy reading scores) are reported in Table 17.

Table 17

Overall Pretest and Post-test Reading Strategy Scores, Higher-order and Lower-order Reading Strategy Scores by the Intervention Condition

Intervention condition	*n*	Reading Strategy Scores					
		Pretest	Post-test	Pre-Higher order	Post-Higher order	Pre-Lower order	Post-Lower order
		M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)
T = 0	105	3.35(0.60)	3.42(0.55)	3.30(0.62)	3.38 (0.55)	3.51(0.75)	3.55 (0.68)
T = 1	102	3.19(0.57)	3.37(0.57)	3.16(0.58)	3.33 (0.59)	3.31(0.75)	3.49 (0.65)

To answer the third research question, I employed paired sample *t*-tests to see whether there was significant difference between the pre- and post-test reading strategy scores within each group. As shown in Table 18, in the experimental group, there was a significant difference between the pre- and post-test reading strategy scores overall ($p<0.01$). Furthermore, there was a significant difference between the pre- and post-test scores of higher-order reading strategy and lower-reading strategy ($p<0.01$ and $p<0.05$ respectively). However, I did not observe any significant difference between pre- and post-test scores among the overall reading strategy scores, higher-order reading strategy scores, and the lower-order reading strategy scores in the comparison group. (See Table 18).

Table 18

Paired Sample T-tests of Pretest Reading Strategy Scores and Post-test Reading Strategy Scores in the Experimental Group

Experimental Group (T=1)	Pretest	Post-test	t-value	df	p-value
	M (*SD*)	M (*SD*)			
Overall Reading Strategy Score	3.19(0.57)	3.37(0.57)	3.20	101	0.0019**
Higher order Reading Strategy Score	3.16(0.58)	3.33 (0.59)	2.98	101	0.0036**
Lower order Reading Strategy Score	3.31(0.75)	3.49 (0.65)	2.39	101	0.0189*

*Note. * p<0.05， ** p<0.01.*

In summary, paired sample T-tests showed that Chinese ELLs employed more higher-order reading strategies ($p<0.01$) and lower-reading strategies ($p<0.05$) after the intervention. However, there was no significant change in reading strategies in the comparison group between pre- and post-test reading strategy scores (see Table 19).

Table 19

Paired Sample T-tests of Pretest Reading Strategy Scores and Post-test Reading Strategy Scores in the Comparison Group

Comparison Group (T=0)	Pretest	Post-test	t-value	df	p-value
	M (*SD*)	M (*SD*)			
Overall Reading Strategy Score	3.35(0.60)	3.42(0.55)	1.23	103	0.22
Higher-order Reading Strategy Score	3.30(0.62)	3.38 (0.55)	1.35	103	0.18
Lower-order Reading Strategy Score	3.51(0.75)	3.55 (0.68)	0.43	103	0.67

Research Question 4

The fourth research question was "To what extent does the use of reading strategies mediate the relationship between the intervention/control condition and Chinese ELLs' reading comprehension controlling for prior English language proficiency (pre-CET-4 score)?"

We hypothesized that the change of reading strategies mediates the effect of ITSS on adult Chinese ELLs' reading comprehension. To verify this hypothesis, I calculated the

indirect/mediation effect and also the significance of this indirect/mediation effect. The results showed that the indirect/mediation effect of the change of reading strategies was -.107, which was not statistically significant (p = 0.401; see figure 4).

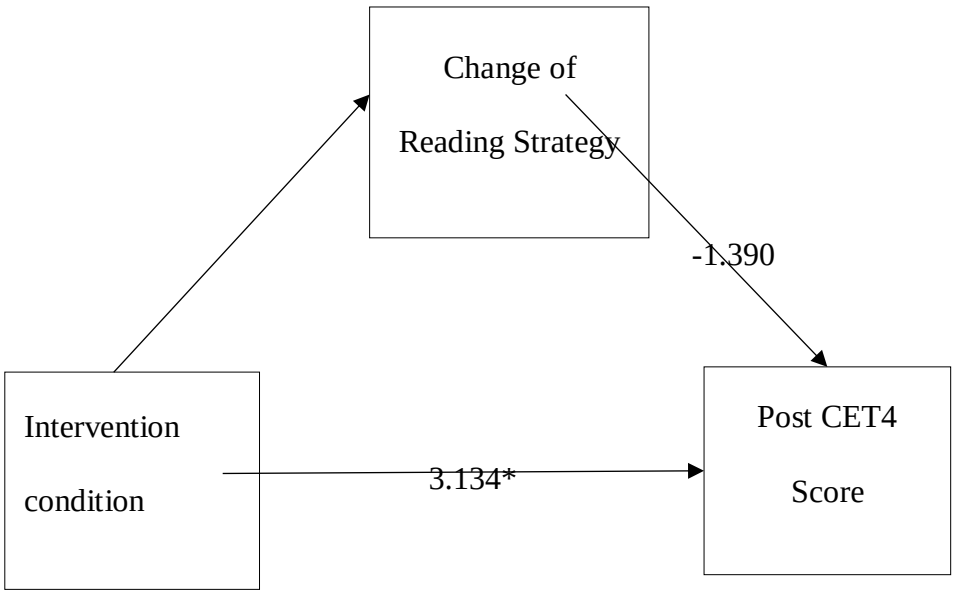

Figure 4. Mediation Effect of the Change of Reading Strategies on the Effect of ITSS on CET-4 Post Score.

CHAPTER V

DISCUSSIONS AND CONCLUSIONS

The primary goal of the present study was to investigate whether the ITSS intervention is more effective in improving adult Chinese ELLs' reading comprehension compared to the traditional instruction on a standardized measure (CET-4) of reading comprehension. My results indicated that after receiving the ITSS intervention, students in the ITSS group performed better in overall reading comprehension skills than the comparison group students, with a medium effect size (d = 0.43). Furthermore, the findings of the current study confirmed my hypothesis that ITSS is more effective in improving students' high-order reading comprehension skills (p<0.001, Cohen's d = 0.49). ITSS was also shown to be effective in improving students' lower-order reading comprehension skills (p<0.05, Cohen's d = 0.25). My study demonstrated that there was a significant change of both higher-order reading strategies (p<0.01) and lower-order reading strategies (p<0.05) in the experimental group between the pretest and the post-test survey. However, there was no significant change of reading strategies in the comparison group. The results of the current study did not detect a mediation effect between intervention/control condition and reading comprehension. Therefore, I cannot definitively say that the change of reading strategies mediated the relationship between the intervention/control condition and Chinese ELLs' reading comprehension.

Web-based Structure Strategy Instruction is Effective to ELLs

The effect size on the reading section of CET-4 (d = 0.43) could be classified as medium. This effect size was larger than those reported in recent, large-scale randomized

studies with elementary monolingual speakers (Wijekumar et al., 2012, 2017), which ranged from 0.1 to 0.2. The medium effect size I found in the present study was comparable to the effect size of Strategy Instruction on the Web for Spanish English Learners (SWELL, a similar system to ITSS) on the standardized GSRT (Gray Silent Reading Test), ranging from 0.47 for Grade 5 to 0.79 for Grade 4 (Wijekumar, et al., 2017). One view of these findings may be that the web-based structure strategy instruction is more effective with ELLs than with native English speakers. However, the measures used are different from GSRT and CET-4, and the conditions of a randomized control group study versus this quasi-experimental design are different. Thus, the results may reflect those differences.

ITSS is an explicit instructional approach to teach students the structure strategy by identifying the signaling words, writing a main idea, and recalling the information (Wijekumar & Meyer, 2006). I hypothesized that this explicit instruction about text structure might especially benefit ELLs. Previous studies indicated that both low literacy Latino readers (Jimenez, 1997; Jimenez, Garcia, & Pearson, 1996) and Chinese ELLs lack structure strategy to understand the text (Li & Li, 2002; Liu, 1995; Yan 2007) due to different cultural and linguistic backgrounds. Chinese ELLs are used to comprehending the text from the word and sentence level. However, better comprehension occurs when readers can communicate with the author at the same level (Bruce, 1980). Thus, if the readers are able to identify the author's top-level structure, the cognitive "conversation" or interaction between the reader and the author will be more successful, and the readers will be more likely to understand the main idea of the presented information (Meyer,

1987). Since ITSS trains the readers to identify the signaling words and recognize the top-level structure of the text, it might be a good remedy for Chinese ELLs who have not learned this strategy.

The effect size of the current study (d = 0.43) was smaller than the effect size of my pilot study (d = 0.67). The difference in effect size between the current study and the pilot study might result from the different motivation level of learning English. In the pilot study, the participants were English majors in a Chinese university and were highly motivated to learn English. For instance, through the pilot experiment, I collected the reflections from the experimental group and observed that the students in this group treated the intervention seriously and were eager to obtain more knowledge about structure strategy via ITSS. From the reflections, I can assume that they valued the opportunity to be involved in the study. I speculated that this high motivation to learn new reading strategies might help them grasp the strategy more thoroughly since higher motivation (interests) usually brings about higher positive learning outcomes (Christophel, 1990; Schiefele, 1991). My finding is also consistent with Wijekumar, Meyer, and Lei (2013)'s findings about high fidelity ITSS. They found that the 4th and 5th grade classrooms using ITSS with high fidelity showed larger effects on both researcher-designed and standardized measures. The effect size of 0.36 at 4th grade and 0.19 at 5th grade on the standardized GSRT test were higher than the other ITSS studies' effect sizes on GSRT (Wijekumar et al., 2012, 2014, and 2017).

In contrast, the current study was conducted with non-English majors in a different Chinese university from the pilot study. This new sample of non-English majors was more

representative of typical Chinese undergraduate students. The participants' interest in learning English in the current study may not be as high as that of the participants in the pilot study. I had 235 students sign the consent forms, but only 207 students completed the full intervention, pre and post-tests of reading strategies survey and reading section of CET-4. Only 88% of the students completed all of the intervention and tests, indicating that they were not highly motivated to study English. However, these students were required to take the CET-4 at the end of the semester, and, therefore, this study is meaningful to establish the effect of ITSS on this important test.

My finding that ITSS is an efficient tool for ELLs is consequential for the increasing number of ELLs throughout the world. ELLs are a highly heterogeneous and complex group of students. Their unique cultural and linguistic backgrounds make them different from native English speakers. For instance, Chinese ELLs are accustomed to reading at the sentence/word level while ignoring the text structure strategy and global organization of text versus native English speakers who are taught to read at the paragraph level. The present study demonstrated that ITSS is an effective instructional approach in the Chinese language context. This indicates that ITSS could be used to improve ELLs' reading comprehension.

ITSS is Effective in Improving Chinese ELLs' Higher-order Comprehension Skills

My study found a significant difference between the ITSS intervention group and the comparison group in adult Chinese ELLs' higher-order reading comprehension skills ($p<0.001$, Cohen's $d = 0.49$). ITSS was also shown to be effective in improving students'

lower-order reading comprehension skills ($p<0.05$,) with a small effect size (Cohen's d = 0.25).

The results from the current study are consistent with the previous findings of the structure strategy approach (Meyer & Poon, 2001; Wijekumar et al., 2013). Readers who use the structure strategy are more competent at recalling important information and also at comprehending texts than those who do not use the strategy (Meyer et al., 1980; Meyer, Young, & Bartlett, 1989; Taylor & Beach, 1984). This is because skilled readers are capable of using an important strategy for reading comprehension—identifying and using the top-level structure of text for both encoding and retrieval (Meyer, 1987). By identifying the author's superordinate schemata that organizes their ideas, the readers can recognize the underlying structure of the text, follow the author's information flow, and summarize the main idea of the information more easily (Meyer, 1987). All of these skills from structure strategy instruction are related to high-order reading comprehension skills, such as making inferences and summarization. When readers are able to identify the underlying structure of the text, it is more likely that they will read between the lines and make inferences about the implicit meaning of the text. Moreover, they are more likely to connect what they read with their prior knowledge and critically analyze and evaluate the present information (Basaraba et al., 2013; Van Kleeck et al., 2006). However, understanding the structure of the text might not lead to direct improvement in vocabulary and word/sentence-level comprehension. This explains why the difference between the experimental and comparison group was small.

Transformation of Reading Strategies Through the Use of ITSS

The results of the current study supported my hypothesis that ITSS can increase the use of reading strategies. Compared with the reported use of the reading strategies before the intervention, Chinese ELLs reported employing more reading strategies after the intervention (higher-order reading strategies [$p<0.01$] and lower-order reading strategies [$p<0.05$]). Overall, the mean score for the reading strategies improved from 3.19 at pretest to 3.37 at post-test, which is a 6% increase. The higher-order reading strategy mean score increased similarly from 3.16 at pretest to 3.33 at post-test. However, there was no significant change of reading strategies in the comparison group between pretest and post-test scores.

An assumption underlying the TSS research is that the ability to identify and use the top-level structure of text for encoding and retrieval is a critical strategy for reading comprehension (Meyer, 1987). In successful reading, competent readers will search for logical relationships that underlie the surface information. In the process of locating the logical structure of the text, the readers might have to employ metacognitive reading strategies such as context clues, self-explanations, prediction, and evaluation. My results illustrated that the use of these strategies helps the readers in understanding the information more effectively (Paris & Myers 1981; Sheorey & Mokhtari, 2001). My findings indicated that when Chinese ELLs had used ITSS for about three months, they reported becoming active readers, engaged in using higher-order reading strategies.

The current study did not support my hypothesis that Chinese adult English language learners improved their reading comprehension through the transformation of

reading strategies. Even though I found that students using ITSS reported increased use of reading strategies, I did not detect the mediation effect through the change of reading strategies on reading comprehension. There might be several reasons for this finding. Even though the experimental group students made large improvements in reading comprehension and reported using more reading strategies, their prior English language proficiency was lower than that of their counterparts in the comparison group. It might be more difficult to identify the mediation effect for the group of people who started from a lower level. Furthermore, the intervention time was limited (10 weeks). A longer intervention may result in different findings for mediation effects.

Significance of the Study and Future Directions

This series of studies opens a window to explore the relationship between the TSS delivered through the web-based intelligent tutoring and ELLs' use of reading strategies through survey of reading strategies. The use of reading strategies might help us understand the complex relationship between the TSS and reading comprehension outcomes. This, in turn, could help researchers gain insight on how and why reading comprehension has improved. Understanding this might generate critical research and pedagogical implications in ELLs' reading practice.

The current study hypothesized that the greater use of reading strategies improved reading comprehension. However, I did not detect the mediation effect of reading strategies on reading comprehension. In the future, researchers should recruit a larger number of participants, increase the intervention time, and endeavor to examine different

populations in various contexts. They should also further investigate the complex correlations between different categories of reading strategies.

Furthermore, my study offered more insight to reading educators about how to design an effective reading curriculum. ITSS uses an explicit set of instructions on the structure strategy, which trains the readers to identify signaling words, write a main idea, determine the organization or structure of the reading passage, and eventually comprehend the text (Wijekumar et al., 2017). In the current study, the participants in the ITSS intervention group only practiced three types of structure in the system—comparison, cause and effect, and problem and solution—due to the time limit (10 weeks intervention). I chose these structures because Chinese ELLs encounter these three genres most frequently in academic contexts. The results of the current study indicated that the ITSS intervention is effective in improving students' self-reported use of reading strategies, which is essential to successful reading comprehension (Alexander & Jetton, 2000; Pressley & Afflerbach, 1995). My findings were consistent with previous studies that explicit training in the structure of text can benefit ELLs' reading comprehension (Carrell, 1984, 1985).

Limitations of the Study

This study had several limitations. First, this research employed a quasi-experimental pretest-posttest design without random assignment. This limited my ability to establish a causal link between the intervention and observed outcomes.

Additionally, this research was conducted for 10 weeks, and further investigations will be necessary to study the longer-term impact of the TSS instruction. Several studies

have indicated that the duration of the technological intervention might influence the learning outcome (Cheung & Slavin, 2013; Xu et al., 2019), and using ITSS for a longer term may result in stronger effects.

Further, the current study used self-reported surveys to explore if the students' reading strategies changed after using ITSS. Future studies should gather data using other sources to discover what reading strategies were used by students.

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APPENDIX

THE SURVEY OF READING STRATEGIES

Directions:

Listed below are statements about what English Language Learners do when they read English textbooks or any English materials.

Five numbers follow each statement (1, 2, 3, 4, 5), and each number means the following:

• 1 means “I never or almost never do this.” (less than 10% of the time)

• 2 means “I do this only occasionally.” (less than 30% of the time)

• 3 means “I sometimes do this” (about 50% of the time).

• 4 means “I usually do this.” (about 80% of the time)

• 5 means “I always or almost always do this.” (about 90-100% of the time)

Level of strategy	Type of Strategy	Strategies	Scale
Lower-level of reading strategies	Literal reading strategies	I go back and forth in the text to connect ideas.	1 2 3 4 5
		I try to guess the meaning of unknown words or phrases by recalling the meaning of a seemingly familiar word, or by analyzing a word in itself (prefix, root and suffix)	1 2 3 4 5
		I paraphrase/ restate ideas in my own words to better understand what I read./ When reading	1 2 3 4 5

		the text, I translate the sentences from English to Chinese.					
		I reread to increase my understanding when reading.	1	2	3	4	5
Higher-level reading strategies	Structure-related Strategies	I try to figure out (decide) the text structure of the passage or paragraph when reading.	1	2	3	4	5
		I summarize what I read to reflect on important information in the text.	1	2	3	4	5
		I use signaling words to help me understand the information when reading.	1	2	3	4	5
	Metacognitive reading strategies	I check to see if my guesses about the text are right or wrong	1	2	3	4	5
		I use context clues to help me better understand what I read.	1	2	3	4	5
		I decide what to read closely and what to ignore (e.g., I skip irrelevant or unimportant words or sentences).	1	2	3	4	5
		I critically analyze and evaluate the information presented in the text.	1	2	3	4	5
		I skim the text first by noting characteristics such as length.	1	2	3	4	5

		I preview the text to see what it is about before reading.	1	2	3	4	5
		I try to guess what the material is about when I read.	1	2	3	4	5
		I correct or change an idea formed earlier in my reading.	1	2	3	4	5
		I ask questions about the text.	1	2	3	4	5
		I elaborate, interpret, or reason with or about a focal segment; bring new information to the focal segment, including relating it to prior knowledge or information in other information segments.	1	2	3	4	5
		I skim through the text and decide the purpose of reading	1	2	3	4	5
		I use typographical aids such as bold face and italics to identify key information (including tables).	1	2	3	4	5

Adapted from Sheorey and Mokhtari's *Survey of Reading Strategies*