How Inference Making Mediates the Relation Between Vocabulary Knowledge and Reading Comprehension for Chinese EFL Middle School Students

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This study aimed to explore the role of inference making in the relation between vocabulary knowledge (breadth and depth) and reading comprehension for 487 ninth-grade Chinese EFL students who were categorized as either struggling or adequate. Path analysis was used to examine both direct and mediated effects. The results indicated a statistically significant indirect effect of vocabulary knowledge on reading comprehension, mediated by inference making, for the entire participant group. However, there were notable differences between the struggling and adequate readers, as evidenced by distinct path diagrams. For struggling readers, the indirect effect of vocabulary breadth on reading comprehension through inference making was significant, while that of vocabulary depth was not significant. For adequate readers, both vocabulary breadth and depth directly explained reading comprehension. These results are discussed in the EFL context, encompassing assessment and instructional implications for EFL readers with varying levels of reading abilities.

Key words: mediation, inference making, vocabulary knowledge, EFL reading comprehension

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1. INTRODUCTION

The recently implemented the *English Curriculum Standards for Compulsory Education* (Ministry of Education, 2022) in China highlights the significance of vocabulary and inference making in the context of reading comprehension, making it clear that middle school students should obtain vocabulary knowledge to comprehend information and viewpoints related to various reading themes within a discourse. Students are required to infer characters' emotions, behavioral motivations, and simple logical relationships between pieces of information. Additionally, they should be capable of interpreting texts from different perspectives, inferring the deeper meanings within a discourse, and making accurate judgements.

Reading comprehension requires both lower-level processes, which involve decoding written language into meaningful units, and higher-level processes, which involve integrating these units into a coherent mental representation (Kendeou, van den Broek, Helder, & Karlsson, 2014). According to Perfetti (2007), the richness of word representation aids both lower and higher-level processes in reading comprehension. Individuals with high-quality and broad vocabulary knowledge can read at a high speed, integrating words into the text. To comprehend a text, readers must draw inferences based on prior knowledge and the propositional meaning conveyed within the sentences of the given text (Perfetti & Stafura, 2014). The successful comprehension of a text requires the effective integration of both lower-level language skills (e.g. vocabulary knowledge) and higher-level skills (e.g. inference making). In L2 reading research, it has been highlighted that both vocabulary and inference play crucial roles in reading comprehension (Kim, 2020a, 2020b; Li & Kirby, 2015; Shen & Crosson, 2023), emphasizing the necessity to enhance training in these areas. However, no specific study has yet fully expounded on the exact relationship among these three variables and the specific mechanisms through which successful reading comprehension is ultimately achieved. In other words, making inferences relies on having a certain level of vocabulary knowledge. Individuals should possess adequate vocabulary knowledge to make accurate inferences and thereby achieve a proper comprehension of the text. Nevertheless, in L2 research, there has been no definitive investigation into the precise strength and direction of these three variables.

Previous L1 studies have proposed inference directly influences readers' text comprehension (Cain & Oakhill, 1999; Kendeou, Bohn-Gettler, White, & van den Broek, 2008; Oakhill & Cain, 2012; Oakhill, Cain, & Bryant, 2003; Oslund, Clemens, Simmons, & Simmons, 2018; Silva & Cain, 2015) and inference mediates the role of vocabulary knowledge on reading comprehension (Ahmed et al., 2016; Cromley & Azevedo, 2007; Daugaard, Cain, & Elbro, 2017; Seger & Verhoeven, 2016). Few studies can verify whether these skills have the same effect on reading comprehension for EFL readers. Moreover, few

studies have revealed the indirect effect of two types of vocabulary knowledge (breadth and depth) on reading comprehension via inference making for different proficiency of readers.

2. LITERATURE REVIEW

2.1. The Effect of Vocabulary Knowledge on Inference Making and Reading Comprehension

Vocabulary knowledge is a complex concept with multiple dimensions, and Anderson and Freebody (1981) propose a categorization into two types. Their argument revolves around the notion that *vocabulary breadth* encompasses "the number of words for which the person knows at least some of the significant aspects of meaning" (p. 93), while *vocabulary depth* delves into "the quality or depth of understanding" (p. 93). In alternative terms, vocabulary breadth denotes the scope of words a person is acquainted with, whereas vocabulary depth signifies the extent to which a person truly grasps these words. Researchers find it imperative to simultaneously examine both aspects to gain a comprehensive understanding of an individual's vocabulary knowledge (Currie & Muijselaar, 2019; Ouellette, 2006; Perfetti, 2007).

Inferences made within a text can be classified as either "forward" or "backward" with respect to the current idea being discussed. *Forward inferences* involve the reader connecting the current idea with their existing world knowledge, and they are often referred to as "elaborative inferences". *Backward inferences* require the reader to establish a connection between the current idea and a previously mentioned idea in the text. These inferences are also known as "bridging inferences" (Birner, 2006, p. 31).

The role of both vocabulary breadth and vocabulary depth in inference and reading comprehension, as expounded by Cain and Oakhill (2014), can be interpreted within the framework of Perfetti's (1985, 2007) *Lexical Quality Hypothesis*. This hypothesis posits that possessing more precise knowledge about words, including their semantic representations and connections with other related words, enhances the efficiency of text comprehension. Concerning vocabulary breadth, an inadequately specified representation of a critical word crucial for making inferences limits the likelihood of successfully drawing that inference. In contrast, vocabulary depth assumes a pivotal role in the inference making process, relying heavily on accurate and comprehensive lexical representations and interconnected semantic networks that enable the establishment of links between thematically related words. Consequently, both vocabulary breadth and vocabulary depth emerge as crucial factors in facilitating accurate inference making and reading comprehension.

A number of studies have found that vocabulary breadth makes a significant contribution to inference (β = .08-.57) and reading comprehension (β = .08-.69), for L1 speakers (Ahmed et al., 2016; Cain, Oakhill, & Bryant, 2004; Cromley & Azevedo, 2007; Currie & Cain, 2015; Daugaard et al., 2017; Davies, McGillion, Rowland, & Matthews, 2020; Florit, Roch, & Levorato, 2011; Jones et al., 2016; Kendeou et al., 2008; Kim, 2017, 2020a; Nash & Heath, 2011; Oslund et al., 2018; Silva & Cain, 2015) and EFL learners (Kim, 2020b), while only a few studies have examined the impact of vocabulary depth (Ouellette, 2006; Segers & Verhoeven, 2016). Kim (2020b) conducted a study to explain the relationships between several components of reading skills and reading comprehension for 201 Korean children in grade 1. The study revealed that vocabulary breadth predicts 41% for inference making and 18% for reading comprehension. Compared to studies focusing on native speakers, there is a scarcity of research about the effect of vocabulary knowledge on inference making and reading comprehension for EFL learners.

To obtain a more comprehensive role of vocabulary knowledge on inference making and reading comprehension, some researchers investigated the impact of both breadth and depth of vocabulary knowledge (Currie & Muijselaar, 2019; Oakhill et al., 2003; Oakhill & Cain, 2012; Strasser & del Rio, 2014). Currie and Muijselaar (2019) conducted a longitudinal study to explore the relationship between vocabulary knowledge to inference among four- to nine-year-old English L1 students. They found that both vocabulary breadth and depth have significant effects on inference making and reading comprehension. Furthermore, inference making is explained more by vocabulary breadth than by vocabulary depth in all grades. Oakhill and Cain (2012) support the finding that vocabulary breadth has a significant effect on later inference making, whereas vocabulary depth does not contribute to the prediction of inference. However, Cain and Oakhill (2014) indicate an opposite pattern of prediction on inference making, namely that vocabulary depth is a stronger predictor for inference making than vocabulary breadth, and this result is supported by Ouellette (2006). In some empirical studies, it has been emphasized that vocabulary depth has a stronger effect on reading comprehension than vocabulary breadth (Ouellette, 2006; Perfetti, 2007). Indeed, there has been no consensus in previous research regarding the effects of vocabulary breadth and vocabulary depth on inference making and reading comprehension. Therefore, it is particularly important to assess both vocabulary breadth and depth to examine the complete role of vocabulary knowledge in inference making and reading comprehension. Additionally, comparing the effect of these two language variables can provide further insights.

When considering individual differences in readers' reading proficiency, the complexity of describing and explaining the theoretical model of reading comprehension significantly increases. Oslund and colleagues (2018) believe that the relationships between various components of reading skills would differ based on students' varying language abilities. A

total of 859 EL1 students in grades six to eight were selected to participate in the assessment of vocabulary breadth, inference making, and reading comprehension abilities. The study found that the impact of vocabulary breadth on inference making and reading comprehension is more pronounced for adequate readers compared to struggling readers.

2.2. The Effect of Inference Making in Reading Comprehension

Both making inferences and comprehending explicitly stated information are crucial for constructing a sufficient representation of text comprehension (Graesser, Singer, & Trabasso, 1994). Thus, inference helps maintain a coherent discourse representation.

The significant contribution of inference making to reading comprehension has been revealed in previous studies for L1 speakers (Ahmed et al., 2016; Cain & Oakhill, 1999; Daugaard et al., 2017; Kendeou et al., 2008; Oakhill & Cain, 2012; Oakhill et al., 2003; Oslund et al., 2018; Segers & Verhoeven, 2016; Silva & Cain, 2015) and EFL learners (Kim, 2020b).

Previous studies have found that inference has varying degrees of effect on reading comprehension ($\beta = .07$-$.31$). Segers and Verhoeven (2016) conducted a study on 146 fourth-grade children and found that inference making explained 31% of the variance in reading comprehension, which is a moderate to large effect. In addition to vocabulary, inference making had a distinct and supplementary impact on reading comprehension. Kendeou et al. (2008) investigated 221 children between the ages of four and eight, demonstrating a significant incremental effect of inference generation on reading comprehension for eight-year-old EL1 children, beyond the influence of fundamental language skills and vocabulary. The predictive validity of children's inference generation ability exhibited an age-related increase. This result was further corroborated by subsequent research conducted by Ahmed et al. (2016). However, these research findings are limited to studies conducted on monolingual individuals. In Kim's (2020b) study, inference making explains only 5% of the variance in EFL reading comprehension. It can be observed that in L2 research, the impact of inference on reading comprehension is not as substantial as seen in studies for L1 readers.

Furthermore, several related studies have further revealed that the impact of inference on reading comprehension varies in strength based on readers' individual English proficiency levels. In the study conducted by Oslund et al. (2018), it was discovered that inference making significantly influenced reading comprehension for readers with adequate proficiency levels, struggling readers, and the entire sample. No statistically significant differences were observed between adequate readers and struggling readers. Similarly, in the study conducted by Cromley and Azevedo (2007), it was also found that inference had a significant impact on 177 EL1 struggling readers in the ninth grade. The inability to make

precise inferences may be a contributing factor to comprehension challenges experienced by students who face difficulties in comprehending written text.

2.3. Indirect Effects of Vocabulary Through Inference Making on Reading Comprehension

In Daugaard et al.'s (2017) study, which involved 62 sixth-grade students, it was found that inference accounted for 22% of the variance in reading comprehension. Moreover, vocabulary had a significant indirect impact on reading comprehension through inference. These findings align with the results reported by Cromley and Azevedo (2007), Silva and Cain (2015), Ahmed et al. (2016), and Seger and Verhoeven (2016), indicating that the influence of vocabulary on reading comprehension is at least partially mediated by inference.

Studies unanimously suggest that children with low reading comprehension abilities struggle with making inferences (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999; Cain, Oakhill, Barnes, & Bryant, 2001; Oakhill, 1982, 1984; Oakhill & Cain, 2012). Research focusing on seven- to eight-year-old children found that skilled comprehenders engaged in more inference generation compared to less skilled comprehenders, although this finding does not extend to elaborative inferences (Cain et al., 2001). Therefore, the impact of inference varies depending on the reader's reading ability. Oslund et al. (2018) found that indirect effects of vocabulary breadth via inference making on reading comprehension are significant for L1 adequate readers, whereas nonsignificant for L1 struggling readers.

Overall, there is a scarcity of research on the impact of inference specifically targeting EFL learners. Furthermore, there is a lack of studies that compare vocabulary knowledge by dividing it into two variables. Research investigating the influence of inference on reading comprehension, considering participants' varying reading abilities, is limited. Additionally, there is a need to investigate how the complex relationships between various reading-related abilities differ among individuals with different reading abilities. The objective of the current study was to investigate how the skill of inference making mediates the relationship between vocabulary knowledge (breadth and depth) and reading comprehension for EFL Chinese middle school students and to examine the extent to which this relationship differs between struggling readers and adequate readers. Two research questions were addressed in the present study:

1) Does inference making mediate the influence of vocabulary breadth and depth on Chinese EFL middle school students' reading comprehension?
2) Do these relations differ when comparing struggling to adequate readers?

3. METHODOLOGY

3.1. Participants

Participants were 487 ninth-grade students (265 males and 222 females) who have been learning English from third grade in their elementary school in China. The students were recruited from two publicly funded middle schools. They attend English classes at school an average of five times a week, and some students receive extracurricular English education to improve their English performance.

The final sample of 487 students included in the study consisted of those who scored either below the 30th percentile (classified as struggling readers) or above the 30th percentile (classified as adequate readers) on the reading comprehension subtest of the *Citywide English Proficiency Test* (Education and Teaching Research Office, 2023). Among the initial 501 students who participated, 14 students (3%) with missing data on the test were excluded since they could not be categorized into either the struggling or adequate readers groups.

3.2. Measures

3.2.1. Vocabulary knowledge

To obtain a more complete assessment of vocabulary knowledge, measures of vocabulary breadth and depth are required to be completed:

Vocabulary Breadth Test

The updated Vocabulary Levels Test (VLT)-Form A, developed by Webb, Sasao and Balance (2017), is designed to assess the breadth of vocabulary among EFL learners. The experiment involved 250 participants, and the results verified the high reliability (.96) as a tool for evaluating the vocabulary breadth of individuals engaged in foreign language learning. The construct validity of the test is examined and analyzed by using Messick's (1989) framework, which has been widely acknowledged as a valuable validation by researchers in the fields of language testing and education (McNamara, 2006). The test contains five words levels with 50 items. Students were asked to select the three correct English words out of six choices to match the three Chinese definitions. Since the *English Curriculum Standards for Compulsory Education* (Ministry of Education, 2022) in China requires approximately 2,000 words for middle school students, the present study required students to finish 20 items with 1,000 and 2,000 word-level. For each correct answer, students were awarded one point, while incorrect answers received zero points. The overall score of the test was 60 and the test's reliability was .92.

Vocabulary Depth Test

Word Associates Test (WAT), originally designed by Read (1993), is one of the most commonly used vocabulary depth testing instruments. It has been employed to evaluate L2 students' vocabulary depth in some studies (Qian, 2002; Susoy & Tanyer, 2018). It is created to assess vocabulary items in the context of a sentence or a larger discourse unit with a more complex test format, not in isolation. However, some items of *WAT* are not appropriate for learners with low proficiency (e.g., beginning L2 learners). Thus, in this study, a total of 24 vocabulary items were taken from English textbooks designed for Chinese EFL middle school students. Students were required to select four correct associations related to a given word out of eight options with a total score of 96 points. The reliability of the test was .94. There were eight options divided into two boxes, the left side contained meaning sense associations and the right side contained the collocation associations. To reduce students' guessing, the answers were unevenly distributed in the two boxes.

3.2.2. Inference making

Inference judgement, Cloze inferencing

Inference judgement and cloze inferencing tasks were taken from *Citywide English Proficiency Test* (Education and Teaching Research Office, 2023). Both the true-false test and cloze test for inferencing were intentionally crafted to assess students' comprehension of the reasoning conveyed in the passage (Greene, 2001). In the inference judgement subtest, students were required to read one expository text and answer five true or false statements. The statements required inferring information not explicitly stated in the text. The cloze test requires students to make inferences by drawing on information provided in sentences other than the one currently being processed. As a measure of inference, the validity of this test format has been improved (Jensen & Elbro, 2022). In the cloze inferencing subtest, students were required to fill in the five blanks with appropriate words or phrases based on the information provided in the context and their own prior knowledge. These include bridging inference and elaborative inference. One point was awarded for each item if answered correctly and the total score value was 10 for two types of inference making tests. The reliability for the measure was .73.

3.2.3. Reading comprehension

Citywide English Proficiency Test

In this study, the reading comprehension section scores of the *Citywide English Proficiency Test* (Education and Teaching Research Office, 2023) were utilized as the measure of students' reading comprehension ability. The *Citywide English Proficiency Test*

(Education and Teaching Research Office, 2023), which was officially organized, underwent meticulous planning and stringent scrutiny to ensure the quality and impartiality. Thus, the appropriateness of test questions, fairness in grading, and rigorous supervision during the examination process are all deemed dependable. These collectively contribute to an accurate and comprehensive assessment of a student's English language abilities. The reading test comprises eight passages, covering various question types, such as completing the article, multiple-choice questions, and subjective questions. One point was awarded for each item if answered correctly and the total score value was 40. The test's reliability was .94.

3.3. Data Analysis

Path analysis was employed as the primary method of data analysis to investigate the direct and indirect relationships proposed in the multicomponent perspective. Path analysis surpasses traditional multiple regression models by enabling the simultaneous inclusion of both direct and indirect relationships in a single model, thereby facilitating the estimation of direct and indirect effects. In the present study, path analysis was performed using Stata version 17 to investigate the direct and indirect relations of vocabulary knowledge and inference making on reading comprehension, as well as differences based on students' reading achievement levels. The study presented model fit indices, specifically comparative fit index (CFI), root mean square error of approximation (RMSEA) and standardized root mean squared residual (SRMR). A good fit indicated when CFI is greater than 0.95, RMSEA is less than 0.05 and SRMR is less than 0.1 (Kline, 2019). These models, which included the full sample, adequate readers and struggling readers all demonstrated good fit to the data, $p = .000$, CFI = 1.00, SRMR = .00 and RMSEA = .00.

The group classified as "struggling readers" was defined as students who obtained scores below the 30th percentile on the *Citywide English Proficiency Test* (Education and Teaching Research Office, 2023). is a commonly recommended benchmark for assessing reading interventions and overall achievement (Torgesen, 2002). This level of achievement has also been utilized in previous studies to identify struggling readers across different age groups (Cromley & Azevedo, 2007; Miciak et al., 2014; Simmons et al., 2011; Vaughn et al., 2011).

4. RESULTS

4.1. Descriptive Statistics

Table 1 provides the descriptive statistics and assessment scores of four testing measures

for the entire sample ($n = 487$), as well as struggling readers ($n = 147$) and adequate readers ($n = 340$).

TABLE 1

**Descriptive Statistics for Struggling, Adequate and Total Sample**

Measures	Struggling ($n = 147$)		Adequate ($n = 340$)		Total Sample ($n = 487$)	
	M	*SD*	*M*	*SD*	*M*	*SD*
VBT (60)	31.73	9.92	46.61	6.08	42.12	10.10
VDT (96)	45.44	16.54	67.78	13.87	61.31	17.84
IM (10)	5.44	2.07	8.83	1.01	7.81	2.11
CEPT (40)	25.20	7.96	38.18	1.65	34.26	7.52

Note. VBT = Vocabulary Breadth Test; VDT = Vocabulary Depth Test; IM = Inference Making; CEPT = Citywide English Proficiency Test

4.2. Direct Effect of Vocabulary Knowledge on Inference Making and Reading Comprehension

In Figure 1, which illustrates the model for the full sample, the variables are represented as nodes in a path diagram, and the relationships between the variables are depicted as arrows connecting the nodes. Each arrow corresponds to a path, and the beta coefficient linked to that path signifies the strength and direction of the relationship between the two connected variables, while considering other variables in the model. A positive beta coefficient ($\beta = .58$; $p < .001$) indicates a positive relationship, meaning that an increase in vocabulary breadth is associated with a corresponding increase in inference making.
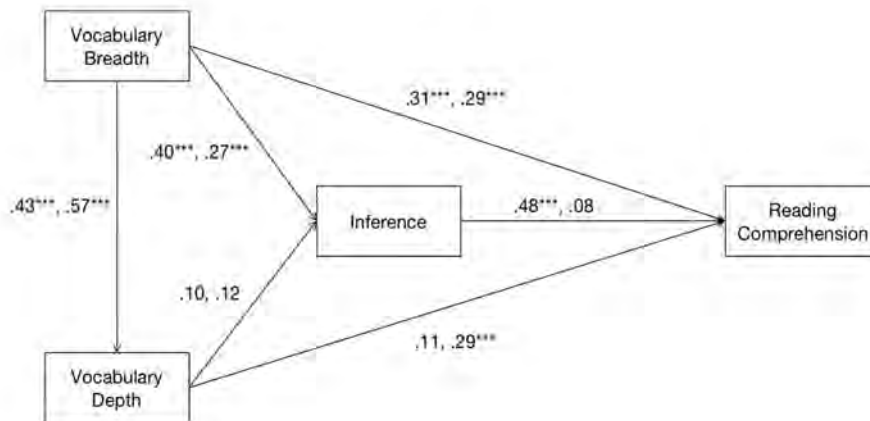
FIGURE 1

Path Analysis for the Whole Sample
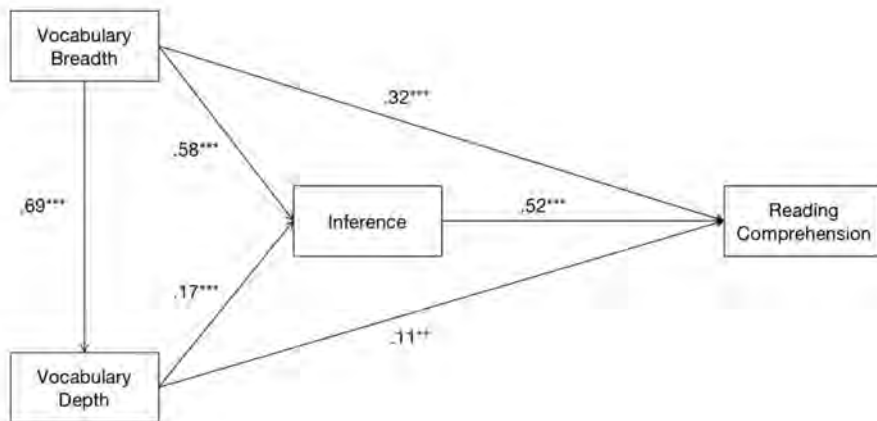
** $p < .01$, *** $p < .001$

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For the full sample, vocabulary breadth ($\beta = .32$), vocabulary depth ($\beta = .11$) were statistically significant predictors of reading comprehension. The path from vocabulary depth to inference making was significant ($\beta = .17, p < .001$) and the path from inference to reading comprehension was significant ($\beta = .52, p < .001$).

FIGURE 2
Path Analysis Comparing Struggling and Adequate Readers

Note. The first number on each path represents the standardized path coefficient from the struggling group; the second number represents the adequate group.
* $p < .05$, ** $p < .01$, *** $p < .001$

Figure 2 depicts the standardized path coefficient of the model comparisons for struggling and adequate readers. The impact of vocabulary breadth on reading comprehension was statistically different for struggling ($\beta = .31$) versus adequate readers ($\beta = .29$), and the effect of vocabulary depth on reading comprehension was only statistically significant for adequate readers ($\beta = .29$), whereas for struggling readers was nonsignificant. Vocabulary breadth had a stronger significant effect on inference for struggling readers ($\beta = .40$) than adequate readers ($\beta = .27$). However, vocabulary depth did not have a statistically significant effect on inference for two groups. Inference making had a significant contribution to reading comprehension for struggling readers ($\beta = .48$), whereas it showed a nonsignificant effect for adequate readers.

4.3. Indirect and Total Effects of Vocabulary on Reading Comprehension

Table 2 presents the results for direct, indirect and total effects. Indirect effects are calculated by multiplying the path from the dependent variable (e.g. vocabulary breadth) to the intermediate variable (e.g. inference making) and from the intermediate variable to the independent variable (e.g. reading comprehension). Total effects encompass both direct effects and indirect effects, representing the overall influence of the independent variable on the dependent variable which is computed by summing up all relevant effects.

TABLE 2
Direct, Indirect, and Total Effects on Reading Comprehension

Varia-bles	Direct Effect			Indirect Effect			Total Effect		
	SR	AR	FS	SR	AR	FS	SR	AR	FS
VB	**.306*****	**.295*****	**.324*****	**.259*****	**.192*****	**.433*****	**.565*****	**.487*****	**.757*****
VD	.112	**.294*****	**.107****	.049	.009	**.088*****	**.162***	**.303*****	**.195*****
IM	**.479*****	.076	**.521*****	-	-	-	**.479*****	.076	**.521*****

Note. VB = vocabulary breadth; VD = vocabulary depth; IM = inference making; SR = struggling reader; AR = adequate reader; FS = full sample
* $p < .05$, ** $p < .01$, *** $p < .001$

The indirect effects presented in Table 2 are calculated based on the direct effects observed in Figures 1 and 2. For the full sample, all indirect and total effects of vocabulary knowledge were statistically significant. The indirect effect of vocabulary breadth on reading comprehension through inference making was .302 (= .58×.52; $p < .001$) and the total effect of vocabulary breadth on reading comprehension was .757 (= .324+.433; $p < .001$). The indirect effect of vocabulary depth on reading comprehension through inference making was .088 (= .17×.52; $p < .001$). The total effect of vocabulary depth on reading comprehension through inference making was statistically .195 (= .107+.088; $p < .001$).

For the struggling readers, the indirect effect of vocabulary breadth on reading comprehension through inference was .192 (= .40×.48; $p < .001$) and the total effect of vocabulary breadth on reading comprehension was .565 (= .306+.259; $p < .001$). The indirect and direct effects of vocabulary depth on reading comprehension were all nonsignificant.

For the adequate readers, the indirect effect of vocabulary breadth on reading comprehension through inference was nonsignificant. However, a significant indirect effect of vocabulary breadth on reading comprehension was observed via vocabulary depth, with a path coefficient of .165 (= .57×.29; $p < .001$). The total effect of vocabulary breadth on reading comprehension was .487 (= .295+.192; $p < .001$). Although the indirect effect of vocabulary depth on reading comprehension through inference was

nonsignificant with a *p* value of .228, the direct effect was .294 (*p* < .001).

5. DISCUSSION

This study revealed that the relationships among reading component variables demonstrated different effects for the full sample, adequate readers and struggling readers. However, previous research rarely conducted analyses based on students' different reading abilities. When analyzing the data across the full sample, significant effects were found among all variables, which aligns with many previous studies. Prior research has seldom explored the relations between multiple reading abilities, including vocabulary breadth, vocabulary depth, inference and reading comprehension, nor has it compared these relationships between adequate and struggling adolescent EFL learners.

For all samples, vocabulary breadth, vocabulary depth and inference significantly influenced reading comprehension. Among these variables, inference had the strongest impact on reading comprehension, followed by vocabulary breadth and vocabulary depth. In the present study, the impact of inference on reading comprehension was larger compared to prior studies, where inference had a small to medium effect on reading comprehension (Ahmed et al., 2016; Cromley & Azevedo, 2007; Daugaard et al., 2017; Kendeou et al., 2008; Segers & Verhoeven, 2016). Consistent with prior research on L1 ninth-grade students (Cromley & Azevedo, 2007), two types of vocabulary knowledge were both significant for inference making in the present study. With respect to the contribution of vocabulary knowledge to inference, breadth of vocabulary had a stronger influence on inference than vocabulary depth. This finding is consistent with the results reported by Currie and Muijselaar (2019) and Oakhill and Cain (2012). Additionally, vocabulary breadth explained 41% of the variance in Korean EFL students' inference in Kim's (2020b) study, which converges with the findings of present study.

For struggling and adequate readers, inference showed different effects on reading comprehension. Inference significantly influenced reading comprehension only for struggling readers, while it did not have a significant impact on adequate readers. However, Oslund et al. (2018) indicated inference had a significant impact on both L1 struggling and adequate readers. Cromley and Azevedo (2007) found that vocabulary had a greater impact on academic text comprehension compared to inference for struggling L1 ninth-grade students. It is important to note that this does not imply that students do not require inference or that it will result in fewer benefits for academic text comprehension. The findings of this study underscore the greater impact of vocabulary on reading comprehension abilities among struggling readers, while indicating a relatively smaller role of inference. Moreover, it is worth noting that inference has a significant role in the

comprehension of text, and the inability to make precise inferences may contribute to challenges in comprehension for struggling readers (Cromley & Azevedo, 2007), which aligns with the finding of this study. With respect to the influence of vocabulary knowledge on inference for two groups, vocabulary breadth predicts inference more proportion for struggling readers than adequate readers, which is opposite to the findings of Oslund et al. (2018), reporting the stronger impact of vocabulary breadth on inference for adequate readers than struggling readers. The reason for the different results may be attributed to the fact that vocabulary knowledge was measured only in terms of vocabulary breadth, without considering vocabulary depth (Oslund et al., 2018). This may have led to an overemphasis on the influence of vocabulary breadth.

There was a moderate indirect effect of vocabulary breadth through inference making on comprehension for the full sample and a small indirect effect of vocabulary depth through inference on reading comprehension for the entire sample in the present study. Consistent with prior research on middle school students (Oslund et al., 2018), vocabulary breadth had a moderate indirect effect on reading comprehension via inference. Cromley and Azevedo (2007) argue that vocabulary directly contributes to reading comprehension and a small indirect effect is observed via inference on reading comprehension for high school students. It is indicated that when the text requires readers to draw logical conclusions, the reader's awareness of the importance of specific words for inference becomes crucial, and the indirect impact of vocabulary on reading comprehension is mediated by the effect of inference. The key distinction between this study and the others lies in the fact that the present study focuses on EFL readers, while the other studies examine L1 readers. It is evident that L1 readers inherently possess higher proficiency levels. Given that reading materials for L1 readers are more challenging, they rely less on lower-level processing, such as individual words but rely more on higher-level reading processes. Consequently, the role of vocabulary knowledge in comprehension is relatively diminished. Conversely, reading materials are less demanding for EFL learners, requiring fewer higher-level processing demands. This amplifies the significance of vocabulary knowledge in reading comprehension.

The indirect effect of vocabulary through inference on reading comprehension showed distinct path diagrams for struggling and adequate readers. The indirect effect of vocabulary breadth through inference on reading comprehension was significant for struggling readers, whereas nonsignificant effects were observed for adequate readers. Conversely, Oslund et al. (2018) revealed a significant indirect effect of vocabulary breadth on reading comprehension via inference for adequate readers, whereas nonsignificant for struggling readers. Daugaard et al. (2017) claim that the impact of vocabulary on reading comprehension is predicted to be partially mediated by inference. Readers frequently employ the semantic relationships between words to draw inferences,

skillfully extracting the precise meanings embedded within the text. In support of this, Pretorius (2000) states that readers infer word meanings based on context, thereby learning new vocabulary, and it is the skill of inference that underlies more general reading comprehension. However, in this study, this path only emerged for struggling readers and was not observed for adequate readers. For adequate readers, vocabulary breadth and depth had direct effect on reading comprehension. Adequate readers benefit greatly from richness of vocabulary breadth in terms of efficient word retrieval and faster word identification (Wise, Sevcik, Morris, Lovett, & Wolf, 2007). Their extensive vocabulary knowledge enables them to effectively retrieve words and rapidly recognize meanings, with less reliance on inference for new words. Furthermore, depth of vocabulary allows them to directly engage in efficient semantic representation of the text, thereby facilitating effective comprehension. (Nation & Snowling, 1999; Ouellette, 2006; Paul & Gustafson, 1991). In essence, struggling readers construct their comprehension of the entire text by first grasping the literal meanings of vocabulary and then inferring the meaning of sentences to comprehend the text. On the other hand, adequate readers possess extensive vocabulary knowledge that, when combined with precise word meanings within specific contexts, supports rapid and accurate reading comprehension.

For adequate readers, the present study did not find a significant effect of inference on reading comprehension abilities. However, this does not imply that adequate readers can achieve comprehension without the assistance of inference. Rather, compared to vocabulary breadth and depth, the relative contribution of inference is relatively smaller for these students. Students with ample vocabulary knowledge can alleviate the burden of comprehending texts and require less reliance on inference. Table 1 illustrates that adequate readers scored 47 out of 60 in vocabulary breadth, whereas struggling readers, scoring only 32, barely achieved half of the questions correctly. With respect to vocabulary depth, adequate readers scored 68 out of 96, while struggling readers scored only 45. These words belong to the 2,000-level vocabulary recommended in the *English Curriculum Standards for Compulsory Education* (Ministry of Education, 2022). The data clearly indicate that the vocabulary breadth and depth of struggling readers did not meet the curriculum requirements. Therefore, these struggling readers should at least acquire the vocabulary specified in the curriculum standards to read texts without significant word-related burdens and achieve successful reading comprehension.

6. CONCLUSION AND LIMITATION

The indirect effect of vocabulary breadth and depth through inference making on reading comprehension is statistically significant for the full sample. The indirect effect

of vocabulary breadth through inference on reading comprehension is significant only for struggling readers. The indirect effect of vocabulary depth through inference on reading comprehension is not significant for both groups. Therefore, for adequate readers, both vocabulary breadth and depth directly account for reading comprehension, whereas vocabulary breadth and inference skills serve as predictors of comprehension abilities for struggling readers.

The study has some limitations because of offline inference. The impact of online verse offline measures of inference on reading comprehension may vary. Online measures, such as think-aloud protocols, eye movement tracking, or assessing response times to probe questions during reading, have been commonly employed. Daugaard et al. (2017) provided additional support for the validity of the inference test by demonstrating that inference scores exhibited a stronger correlation with comprehension of texts characterized by high inferential demands compared to texts with low inferential demands. The inference measurement employed in this study involved relatively low-level inferencing, and the level of inference required from readers can also influence reading comprehension. Therefore, future research could enhance the measurement of inference by considering factors such as types of inference, inference time, and levels of inferencing required.

Applicable level: Secondary

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