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Research On the Application of Mind Map to Reading Comprehension Teaching in Middle School

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Abstract
English reading is regarded as an important way for students to obtain information and enlarge vocabulary. Reading ability of students always significantly influences the English comprehensive skills. Meanwhile, multidisciplinary integration requires active thinking ability to cope with various and more flexible questions in English reading comprehension. Therefore, employing mind map in English reading comprehension teaching will be beneficial to students. Passages can be connected through key words or phrases and graphics. Students can not only understand passages as a whole, but also command the details. In this way, students' reading ability and reading strategy will be facilitated dramatically.

The researcher selects 50 students as participants from one class of a junior high school in Shangluo City, Shaanxi Province. The study will last for two terms. Students will taught by the means of mind map in reading comprehension teaching in the second term while they will be lectured with the traditional method in the first term. The SPSS analysis of pre-test and post test scores showed that students after implementing mind map based teaching performed better than after implementing traditional method, indicating that the reading level and ability of students have been improved with the most remarkable enhancement the most remarkable enhancement at interpretive comprehension from low to moderate, then at literal comprehension remaining moderate, with value increasing. The evaluative comprehension stay the same as low. They can better utilize reading strategies to complete reading comprehension. This study suggests that using mind maps in middle school English reading teaching is effective.

Keywords: mind map, mind map based teaching, reading comprehension

Introduction

English as lingua franca is still playing an important role by connecting with countries across the world. Many countries regard English as a main course in schools like junior high school. English reading serves as a way to gain some information and is much emphasized. Krashen (1988) pointed out that language proficiency is the result of meaningful reading, which is the source of most of our vocabulary knowledge, writing style, advanced grammar skills, and spelling. Through reading, students can not only consolidate their language knowledge, master reading techniques and strategies, but also learn about the excellent cultures of various countries around the world to broaden their international perspectives, thus enriching their cultural connotations and awareness, as well as cultivating a positive and healthy emotional attitude. Reading ability is very significant in English learning.

In the English test paper for the Shaanxi Provincial Middle School Entrance Examination, reading section takes up about 40%. Besides, in terms of the forms of assessment, they are becoming increasingly diverse. In addition to traditional reading comprehension questions, question and answer forms and fill in the blank reading have also been involved, making the forms of assessment more flexible and diverse (Zhang Ke,2018). It's more difficult for students to deal with the reading part. Reading ability is not only a language skill that we need to master, but also an important way for us to acquire language intake from the outside world (Huang Baozhu, 2021). The new version of the "Compulsory Education English Curriculum Standards" released in April 2022 raise high requirements for students' reading ability. Therefore, middle school English teachers should transform their traditional teaching mode, optimize and innovate teaching methods and deliver some reading skills and cultural knowledge, to improve students' reading ability. Therefore, teachers are required to help students train their reading techniques and reading strategies and foster their thinking ability by adopting proper teaching methods, thus improving their overall reading ability.

At present, examination-oriented trend still exists in schools. In traditional English reading teaching methods, the teacher first explains the key and difficult words of the lesson, then students do some exercises based on the paragraphs. Later on, teachers translate the text and explain the key grammar points of the lesson. The students memorize the text after class. They don't pay attention to logical sorting and systematic analysis. It to some extent neglects the process of students autonomously analyzing and constructing discourse by adopting reading strategies, resulting in a lack of independent thinking training opportunities for students and low classroom participation . On the top of that, fragmented knowledge appear in students' mind without forming a logical and systematic system, which reduces their leaning efficiency. Students lack subjective initiatives and ability of independent thinking and finishing assignment (Dymoke, S., 2008). This method mainly relies on the teacher's explanation, and students passively receive knowledge. Due to the lack of in-depth analysis of the reading text, students are unable to understand the main idea of the article and the logical relationship between paragraphs. They also lack the ability to expand the

connection between reading materials and reality, thus losing their enthusiasm for exploring reading and hindering the cultivation of their reading ability. Teachers fail to train students in reading strategy and discourse competence. They seldom offer chances for students to have training for reading techniques and overall comprehension of reading materials. By the second year of junior high school, students undertake heavy workload in English learning with the length and difficulty of English articles increased. Over time, they will lose interest and enthusiasm for English reading. The problems: How can teachers teach English reading in a methodical, effective, and meaningful manner; How can students actively, creatively, and deeply learn have become a question worth exploring.

Mind maps put forwarded by American scholar Tony Bozan operas in accordance with human brains, visualizing the students' thinking process. It can connect language points, key words, enhancing students' memory and stimulating their creativity (Buzan, 1991). The research is designed to explore effective reading teaching methods by applying mind maps to English reading teaching in junior high school.

Reading Theories

Schema Theory. German philosopher Immanuel Kant, in 1781, first proposed the concept of "schema", stating that "schema" refers to the cognitive or knowledge structure that learners already have. Schema aims to connect the new knowledge people just access with what they obtained, promoting better understanding and memorizing new information and completing the existing one. When reading some materials, the process of learners' comprehension is the interaction between the existing schema in their minds and language materials provided. Once leaners integrate new information into the obtained schema, showing that it's a meaningful reading. Reading ability is determined by three types of schemas: language schema, content schema, and formal schema. Carrell (1983) pointed that language schema refers to the reader's existing knowledge of phonetics, vocabulary, and grammar. Content schema is background knowledge related to reading texts including historical and cultural background, learners' personal life experience and so on. Formal schema refers to knowledge related to logical structure. Learners can understand reading materials literally in accordance with basic language knowledge they've gained based on language schema. Language schema is a prerequisite for readers to apply content schema and formal schema. The background information of learners can be activated to facilitate their comprehension and consolidate new knowledge with the help of content schema. At last, as about formal schema, learners can analyse text framework and features and comprehend the in-depth meaning of the reading materials. In that case, the whole reading process involves students' initiative instead of passive learning in traditional reading.

Knowledge Visualization Theory. Scholars such as Chen Bikun believe that knowledge visualization is the process of collecting, processing, and disseminating different types of knowledge through visual analysis of explicit and implicit knowledge, ultimately achieving the correct construction, memory, and application of knowledge (Chen Zhao, 2015). Knowledge visualization conforms to the way and process of cognizing in the brain, and it can simultaneously

use visual information and language to act on the brain, which is very beneficial for the memory process. Besides, it can help grasp more information in a certain period of time (Deng, 2018). The core principle of knowledge visualization theory is that presenting information in both linguistic and visual forms simultaneously enhances memory effectiveness. Texts are presented graphically, which provides excellent assistance and supplementation for language- based understanding and greatly reduces the cognitive load of language channels and accelerates the occurrence of thinking (Zhao, 2013). Knowledge visualization can deal with image processing on reading texts, playing a role as a "relay" and "bridge" between reading text and students. This presentation method is beneficial for students to clarify the relationships between things in the text, deepen their understanding of the text, and construct knowledge, thereby cultivating their comprehension ability and innovative thinking.

Constructivism Theory. The constructivism learning theory was proposed by J. Piaget in 1966. Constructivism theory emphasizes the active constructiveness of learning, and the process of constructing knowledge relies on human experience and understanding (Piaget, 1970). In the process of learning, students should proactively complete the construction of their knowledge system, that is, the process in which learners use their existing experience and knowledge to actively explore and construct their knowledge system (Zhou, 2018). The core of constructivism emphasizes students' active discovery, exploration, and construction of the knowledge they have learned (Willis, 1996). Learners initiatively receive knowledge, rather than being passively indoctrinated with it. On the basis of certain prior knowledge and experience, they actively construct meaning for external information and environmental new elements with the help of external resources and means. Teachers only provide guidance and supervision in teaching, rather than playing a leading role. They mainly stimulate students' subjective initiative and self-directed learning, requiring them to actively discover new knowledge and engage in meaningful learning. According to Krashen's (1982) proposal of "i+1" comprehensible language input, that in the classroom, the knowledge input by teachers should be slightly higher than the current level of students. Teachers should first build scaffolding for students and help them construct conceptual frameworks; By creating scenarios, it’s key to guide students to explore more meaningful knowledge and information independently or collaboratively beyond their current level; Then they help students conduct self-evaluation and peer evaluation to verify learning outcomes.

In summary, the application of mind mapping embodies schema theory, knowledge visualization theory, and constructivist theory. This study is based on these three theories to investigate the application effect of mind mapping on middle school students' English reading learning, and explore effective teaching methods.

Research questions

The study aims to apply mind maps to English reading teaching in junior high schools and testify the effectiveness of reading teaching based on mind maps from the perspective of students’ reading ability in order to explore an effective reading teaching way, specifically it aims to address the following questions:

1. What is the students' level of reading comprehension before the implementation of mind-map based teaching?

2. What is the students' level of reading comprehension after the implementation of mind- map based teaching?

3. Is there a significant difference in the reading comprehension before and after the implementation of mind-map based teaching?

Literature Review

Mind maps, have been widely used in the field of education, especially in English teaching, since their proposal by British scholar Tony Buzan in the late 1960s. Many scholars and educators at home and abroad have conducted in-depth research in this field, exploring the potential of mind mapping in improving the quality of English teaching and student learning efficiency.

Mind Map Based Teaching Reading. Foreign and domestic researchers have applied mind maps to English reading teaching to verify their usability and applicability. The author has reviewed and summarized the research literature of foreign scholars on the application of mind maps in English teaching, mainly focusing on the following aspects:

In foreign countries, in terms of improving reading comprehension in English reading teaching, Andriani (2017) applied mind maps to the English reading teaching of eighth grade students. By comparing the classes using mind maps with those using traditional teaching, it was analyzed that the English reading scores of the experimental class was improved. The final conclusion was that the English reading scores of the class using mind maps were significantly higher than those of the control class. Siriphanich (2011) reported a survey conducted in college English reading classes on whether the use of mind maps can improve reading comprehension abilities. The study showed that students' English reading comprehension test scores improved and they were also satisfied with their reading abilities. Sarah and Nick holds that mind map can be used as auxiliary tool to help teachers to improve teaching efficiency. Besides, the method of locating key words or phrases in English class can also be beneficial to English reading teaching.

On the part of boosting students' ability in discourse disposal, Farrand (2002) pointed out that mind maps are more helpful for students to memorize textual information and easily recall the main content and ideas of reading materials, thereby extracting key information. Clarke (1991) mentioned that mind maps in English reading teaching, can help students better understand and memorize texts. For example, students can clearly compare and contrast different concepts, by using Venn diagrams or double bubble diagrams, thereby better understanding the structure and essence of the text. This allows students to quickly restructure the discourse structure of the reading text, thus improving their grasp of the deeper information in the text. Anna Buran (2015) mainly studied the performance of mind map teaching aids, focusing on middle school students. She found that middle school students' abilities in reading skills, problem-solving, public speaking, and presentation were all improved when using mind maps to learn English, with an effective rate of up to 96%. This undoubtedly proves that mind maps are an efficient language learning aid for middle school students in the process of English reading.

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At home, in the aspect of the design of mind map based reading teaching, Chen Min (2005) further confirmed the effectiveness of using mind maps in middle school English reading teaching through empirical research, and put forward several suggestions for the practical application of mind maps. Based on the analysis of the current middle school English reading teaching mode, Jin Xiaoling (2021) proposed feasible suggestions for teachers to apply mind maps to reading teaching. She believes that teachers can use mind maps to explain key knowledge and analyze frameworks, and conduct professional evaluations. Zhang Qiaomei(2016) explored the application of mind map in English reading teaching in the session of pre-class, while-class and post-class. In pre-class, students predict the passage and try their best to draw their own mind maps. Then, in class, they perfect their mind maps through the guidance of teachers. After class, they retell and review the passage by using the mind maps. It's suggested as an effective teaching method.

In terms of effectiveness of mind map based reading teaching, Zhang Yanwen (2016) believes that mind mapping can alleviate the academic pressure and burden on students, provide a relaxed atmosphere for their English reading learning, and alleviate their fatigue. Gu Min (2014) Can mind maps promote students' reading quality. Using mind maps as a visual teaching tool can help teachers establish connections between knowledge points in reading teaching design, organize the overall content framework, improve the reading teaching process, and explore whether the use of mind maps in teaching design can improve students' thinking ability and enhance the quality of reading teaching. He Yanmei (2015) explored the application of mind maps in middle school English reading teaching. With the proposal of the new curriculum reform, higher requirements have been put forward for teaching various subjects and innovative classrooms for teachers. It is believed that teachers should focus on imparting reading strategies to students and cultivating their autonomy, and mind maps are a good choice. Using mind maps can simplify complex reading content and promote students' comprehension and memory of the content. Research has shown that mind maps can improve students' English reading abilities; Mind maps can promote communication between teachers and students; Mind maps have led to positive changes in students' interest and behavioral habits in learning English.

In summary, there has been a certain amount of research on the application of mind maps in the field of English teaching, which to some extent reflects the important role of mind maps in teaching and provides important theoretical basis for future researchers. However, in the context of the new curriculum reform, there is almost no research that matches the content of the curriculum. Most of the research is conducted according to traditional thinking, so research can gradually shift towards the cultivation of comprehensive qualities such as thinking quality, core literacy and reading ability. This study applies mind maps to frontline teaching, seeking a more effective way to use mind maps

in English reading classes.

Methodology

Data were collected by merely two reading tests. The method is mainly quantitative.

Participants of study

Students are selected from one class of Grade eight in a junior high school in Shangluo City, Shaanxi Province. After one year of study, the students have established a certain foundation in English. They are also faced with long English texts and a large amount of reading, so it's necessary for them to grasp correct and effective reading strategies and techniques to improve their reading efficiency. The number of students in the class is 50 with 25 boys and 25 girls. The class will be taught by the same teacher for two terms, which will be easier to collect data. In the first term, traditional teaching method is employed for ten weeks while mind map based teaching is utilized in the second term for ten weeks. They learn the teaching contents with textbooks published by Foreign Language Research Press. Through analysis of scores of their English entrance examination, students are divided into three levels according to overall English scores. So this class can be looked as the subjects of the research.

Instruments

The research will adopt tests to explore the effectiveness of mind maps in English reading teaching. Therefore, the research will be quantitative.

English tests are set after implementing traditional teaching method and after implementing mind map based teaching method. English examinations are both complied by Bureau of Education in Shaanxi Province according to the Compulsory Education English Curriculum Standards and English learning level of local students. Therefore, the papers have reliability and validity. All test papers consist of five articles, mainly narrative and expository essays, to assess students' English reading ability. Basic and medium difficult questions make up the majority, so for students who have just started their second year of junior high school, the difficulty of the questions is moderate. So they are reliable and valid. Students in the class are asked to attend these two examinations carefully.

Data Gathering Procedure

This study falls into two stages, namely two semesters. In the first stage, the teacher taught students from Class 9, Grade 8 using traditional reading teaching methods. In the second stage, when students are instructed by using mind maps to teach English reading in the same class.

Procedure

The following part copes with the implementation procedure and data collection.

Implementation procedure

Adopting Traditional Method . In the first section, students was taught by the traditional teaching method for ten weeks. The procedure is as follows:

1. Pre- reading activities

a. The teacher teaches and explains new words.

b. The teacher leads in the topic through some questions and guides students to discuss.

2. While-reading activities

a. Students were asked to locate the main idea sentence and topic sentence of each paragraph and answer the corresponding questions. Then, teacher checked answers.

b. Students were asked to complete tasks and after-class exercises and then teacher checked answers.

c. The teacher explains the long and difficult sentences and translate them. Then, students were led to read them.

3. Post-reading activities

a. The teacher leads students to review the whole passage and key points.

b. Students were required to recite the passage or important sentences and paragraphs.

Adopting Mind Map Based Method

(1) Preparation Phase In the second section, teachers need to adopt a mind map reading teaching mode for the same students. In order to help students fit in the mind map teaching mode in English reading teaching, the author first makes training of one week for students to understand the meaning, features, especially the drawing methods of mind maps.

(2) Implementation Phase

1. Pre-reading activities

a. In lead-in part, the teacher brainstorm students for topics related to the article and closely linked to life through questioning, helping students review the knowledge they have learned before. At the same time, teacher draws a simple mind map on the blackboard, and teach new words or phrases in the text appropriately.

b. The teacher requires students to make predictions about articles based on reading titles, text illustrations, etc., in order to enhance their association.

2. While-reading activities

a. Students draw the theme words and primary branches of a mind map through scanning. The teacher asks' What's the main idea of the passage? 'or' What is the passage mainly about? ', to guide students to scan the article title and the beginning and end sentences of each paragraph, summarize the main idea or general idea of the article, understand the overall framework of the article.

b. Students can complete diverse reading question types such as answering questions and filling in the blanks with choices similar to those in the middle school entrance examination through careful reading.

c. Under the guidance of the teacher, students carefully read each paragraph, identify key sentences and keywords, draw the second or third level of the mind map step by step, and discuss their mind maps in the group. Teachers observe the drawing process of some students, explain some problems, and help them correct mistakes in a timely manner, making their thinking clearer.

d. Teachers can expound some important knowledge points through questions and mind maps, combined with actual teaching situations.

e. The teacher asked each group to present one or two classic mind maps for evaluation, promptly correcting any problems in students' drawing, and displaying the prepared maps on the screen.

3. Post-reading activities

a. Discuss the article with the help of a mind map. The teacher can set corresponding questions to inspire students' thinking and engage in group discussions, where they can express their own opinions and deepen divergent thinking.

b. Retell the article with the help of a mind map. After reading, the teacher can ask students to retell the passage in order to deepen their profound understanding of the text. Praise and encouragement should be followed them in time, and help them improve their confidence. Teachers must provide feedback at any stage when students answer questions and demonstrate themselves.

(3) Post-implementation Phase

After the experiment, reading comprehension tests will be conducted on students to determine whether mind maps can improve their English reading scores. Finally, the author analyzed and compared the survey test data with SPSS, and draw conclusions based on the research findings. At the same time, the author also reflected on the areas that still need further improvement and breakthroughs when using mind maps for English reading teaching.

Treatment of Data

The data in this study is made up of two reading scores pre-test and post-test. But reading section results will be extracted to a single excel chart, which will be analyzed and compared. The SPSS software will be utilized to analyze the data collected.

Results and discussions

This part focuses on the analysis of experimental results and discussion of data collected pre-test and post-test.

Results of the study

Analysis of reading comprehension before mind map teaching

In order to get the students' level of reading comprehension before the implementation of mind-map based teaching, the following analysis is conducted.

Table 3-1

The students' levels at three dimensions of pre-test

Dimension	Average (%)	Level
Literal Comprehension	66.67	Moderate
Interpretative Comprehension	57.14	Low
Evaluative Comprehension	50.00	Low
Overall	**60.70**	**Moderate**

From this table, it can be concluded that before using mind maps for reading teaching, the average score at literal comprehension is 66.67% as moderate which is included in 60%-79% in accordance with the Table of Interpretation Used to Describe Levels of Reading Comprehension. The literal

comprehension is the simplest type of reading question, and students only need to use keywords to locate the information, do the questions carefully and seriously, then they can get it right. The requirements for students' capability are relatively low. Years of English learning has helped junior high school students develop a certain level of proficiency in basic skills such as vocabulary recognition and sentence structure analysis. They can decode and comprehend facts, details, and event sequences explicitly stated in texts by utilizing their acquired grammar knowledge and vocabulary. While this ability has not yet reached full automation, it has progressed beyond the initial stage of controlled processing, reaching a partially automated state. Therefore, when faced with texts of comparable difficulty to their textbooks, they can complete basic information extraction either under teacher guidance or independently. But in the process they may still review texts repeatedly and relatively slow, reflecting instability when encountering complex sentence structures or slightly more unfamiliar vocabulary. This is the hallmark of a "moderate" proficiency level: being capable of completion but lacking in fluency, efficiency, and consistency.

The mean score 57.14% is accounted for as low, which is lower than 60% at the interpretive comprehension. Reading comprehension is the process in which readers construct meaning by adopting their existing background knowledge (i.e., schema) to interact with textual information. Successful interpretive comprehension such as inference and summarizing the main idea, requires readers to possess linguistic schema like vocabulary and grammar, content schema like background knowledge on the topic, and form schema (stylistic structure) related to the text. Having insufficient linguistic schemata, Students' vocabulary and syntactic knowledge may only suffice for literal comprehension. When required to infer the meanings of unfamiliar words (guessing from context) or understand implied meanings, their limited linguistic schemata become a hindrance. Lack of content schema signifies insufficient understanding of the culture and social knowledge of English speaking countries, which makes it difficult for them to fill in the information gaps in the text and make logical inferences across cultures and backgrounds. Not familiar with the common organizational structure of English articles makes it impossible for them to effectively predict content development and summarize the main idea of the text, which results from ambiguous formal schema. Hence, the low level of interpretive comprehension exhibits that they are not equipped with the ability to make inferences and make a summary of the main idea of a paragraph or passage, let alone the understanding of the intention of characters or the implicit themes of the text.

As about evaluative comprehension, 50% also shows a low level (<60%). Interpretive questions require students to reason and summarize, which has a certain level of difficulty, while evaluative questions compel students to open their minds and think more. We can see the inadequacy in evaluative comprehension. It is concerned about the structure and title of the article, which enables students to have an overall grasp of the article, clarify the organizational structure of the text, the writing intention of the article, to a higher level. Evaluative comprehension not only demands readers to fully understand the text at the level of "analysis", but also step out of the text. The viewpoints, argumentation process, writing techniques, or social impact of the article are evaluated

with critical thinking and combining personal knowledge, values, and external standards.

The overall average score of the three dimensions arrives at 60.70% with a range from 60% to 79%. Therefore, the students' level of reading comprehension before the implementation of mind-map based teaching is moderate. It means that they can reconstruct the meaning concisely expressed in the text and make simple inferences and connections under guidance. The structural characteristics of students' reading ability before the experiment clearly outline the bottleneck of junior high school students in EFL learning. The structural characteristics of students' reading ability before the experiment clearly outline the bottleneck of junior high school students in EFL learning. The accumulation of their basic language knowledge in vocabulary and grammar has got to a level that can support literal comprehension of moderate level , which forms the basis for their assessment of overall ability as "moderate".

Analysis of reading comprehension after mind map based teaching

In order to learn about the students' level of reading comprehension after the implementation of mind-map based teaching, the following analysis is carried out.

Table 3-2

The students' levels at three dimensions of post-test

Dimension	Average (%)	Level
Literal Comprehension	77.78	Moderate
Interpretative Comprehension	71.43	Moderate
Evaluative Comprehension	50.00	Low
Overall	**66.40**	**Moderate**

In Table 3-2, the average score of literal comprehension after implementing mind map based teaching rises to 77.78% compared with 66.67% by 11.11% before using mind map based teaching. 77.78% almost approaches 79%, but still belongs to moderate level. At this point, students basically enter automation stage where they can locate and extract key facts, details, and the sequence of events in an article in an independent and accurate way. The improvement in literal comprehension scores is due to the maximization of the efficiency of applying mind maps to students' existing language knowledge. Students have demonstrated a better level of proactive and in-depth information encoding within their current abilities by optimizing information processing strategies. Mind maps can effectively consolidate and optimize students' literal comprehension by promoting deep encoding and constructing clear schema, thereby enabling them to maximize their effectiveness at their current language level.The reason why its level still presents "moderate" is that students' core language abilities have not yet universally crossed the critical threshold required to jump from "moderate" to "high". As strategy optimization contributes to progress, its literal comprehension is unlikely to undergo a qualitative change before reaching this threshold of high level. Mind maps as a metacognitive strategy and organizational tool, mainly functions as the optimization of students' applying existing knowledge. However, it cannot significantly expand students' vocabulary or accelerate their syntactic processing speed in the short term.

Interpretative comprehension also displays an upward from 57.14% to 71.43% with an increase of 14.29%, reaching the moderate level. More specifically, students can make simple and direct inferences about texts, understand simple causal relationships and generally summarize the central idea of the article. The reason is that students just transcend from existing development zone to proximal development zone, proposed by Vygotsky. Students' ability to independently solve problems is defined as existing development zone while their potential level, that is, interpretive comprehension such as inference and summarization under guidance is thought as proximal development zone. Mind maps externalize the internal logical relationships of text through their hierarchical structure and visual presentation. This is equivalent to building a 'scaffold' between students' current cognitive level and target skills. It releases valuable working memory resources by reducing the external cognitive load of organizational information, allowing students to focus on advanced thinking activities such as inference and generalization. Moreover， the language input teachers give students is just a bit beyond their current level of competence. In other words, the language which learners are exposed to is just beyond their current competence and they can understand most of it, but a little challenged. There exists a proper space for them to make progress. As a consequence, the interpretative comprehension rises from low to moderate.

Evaluative Comprehension remains at the same level- low. The questions require a deep understanding of the article before they can be completed, and belong to a relatively high level of reading questions. This ability requires long-term cultivation and cannot be improved in a short period of time. Comprehensively, the overall mean score goes up to 66.40% from 60.70% in moderate level. All in all, the students' level of reading comprehension after the implementation of mind-map based teaching remain moderate, even if there’s an increase in the value. Bloom divides cognitive processes from low to high into six levels: memory, understanding, application, analysis, evaluation, and creation. Evaluation ranks the second to last higher-order position, which takes on the capability of making judgments and criticisms of things, methods and perspectives, etc. based on specific standards and criteria. At the same time, crossing levels means crossing a language and cognitive threshold. Mind maps can well demonstrate "what" and "why" in the text , but they do not educate students "how to evaluate" in a straightforward way.

Comparative Analysis of reading comprehension between before mind map based teaching and after mind map based teaching

In order to understand the differences in students' English reading scores pre-test and post-test, the researcher compared the English reading scores of the two tests.

Data results of Pre-test and Post-test and Paired samples test between Pre-test and Post-test are shown in Table 3-3.

Table 3-3

Paired Samples t-Test Results for Overall Reading Comprehension

Pair	M(%)	SD	*t*	*df*	*p*	*d*
Before mind-map based teaching	60.70	21.17	-5.33	49	<.001	-.75
After mind-map based teaching	66.40	20.00				

From Table 3-3, through the paired sample analysis, it can be concluded that the average reading score of students before using mind-map based teaching is 60.70%, while the average reading score of students after using mind-map based teaching is 66.40%. The latter is higher than the former. The standard deviation increased from 21.17% to 20%. This indicates that after a period of experimentation, students' reading scores showed an upward trend after employing mind-map based teaching. The degree of freedom df for is 49, t（49）=-5.33，sig(two-tailed),p=0.001＜0.05，which suggests that there is a significant difference between utilizing mind map based teaching and traditional teaching. It also proves that through a teaching experiment of applying mind maps to junior high school English reading teaching over a period of time, students' reading grades have improved to some extent compared with that of using traditional teaching, and their overall reading level has been positively affected.

Constructivism puts forward that knowledge is actively constructed by learners in the process of interacting with the environment， instead of passively receiving. Learning is a process in which learners actively process information and form meaning based on their existing experiences. Students must personally analyze, judge, and organize the text in the process of drawing a mind map. Then they have to determine what the central theme is, what the main branches are, what the key details are, and what the connections are between them. The procedure itself is an active construction of the meaning of the text. Each student's mind map is imprinted with their personal understanding. This kind of knowledge constructed through personal participation is far more deeply understood and sustained than knowledge passively received. Therefore, they are able to apply this knowledge more flexibly and stably to solve problems in testing. It is precisely this multidimensional and deep level cognitive intervention that fundamentally optimized the reading information processing mode of students after the experiment, resulting in a significant improvement in average reading scores compared to that before the experiment. This discovery strongly demonstrates the scientific and effective integration of mind maps into middle school English reading teaching.

In order to further explore at which levels students' reading ability have strengthened, a Wilcoxon signed-rank test was conducted to compare comprehension scores before and after the implementation of mind-map–based teaching.

Table 3-4

Wilcoxon Signed-Rank Results for the Dimensions of Reading Comprehension

Variable Pair	Md (Before)	Md (After)	*z*	*p*	*r*
Interpretative Comprehension(14)	57.14	71.43	-3.87	<.001	-.55
Literal Comprehension(18)	66.67	77.78	-3.93	<.001	-.56
Evaluative Comprehension(8)	50.00	50.00	-.89	.371	-.13

Regarding the Interpretative comprehension, in Table 3-4, it is evident that the average score after the application of mind map based teaching increased by 2.2 from 71.43% to 57.14% in comparison with that after utilization of traditional teaching. The findings support the conclusion that the significant value Sig 0.001 (z = –3.87, r = .55) is less than 0.05, indicating a notable difference between the two Interpretative results in light of the paired sample analysis data. This means that after using mind map based teaching, there is a remarkable enhancement in students' ability of Interpretative comprehension. Based on the analysis, this reveals that application mind map based teaching has led to the progress made by student in abilities of reasoning, judgment, and summarizing the main idea a certain degree.

For literal comprehension, the data of Table 3-4,can be interpreted as an increase of the mean value 2.00 from 66.67% to 77.78% after conducting mind map based teaching. The paired sample analysis data will be displayed to illustrate observation further. The significant probability Sig value of 0.001(z = –3.93, r = .56.) is less than 0.05, indicating a significant difference between the two results in the literal level.

As for the evaluative comprehension, the average score after the traditional teaching method is 50%, the same as 50%. As indicated by the paired sample analysis data in Table 3-4, it can be concluded that the value of Sig (two-tailed) is 0.371(z = –0.89, r = .13), which is greater than 0.05, suggesting that there is no significant gap between the two. It demonstrates that after using mind map based teaching, there is no notable difference in students' ability in the evaluation aspect.

Mind maps use keyword extraction and hierarchical structure to visually classify facts, details, and order in texts. This enables students to quickly and accurately locate and extract information, greatly optimizing efficiency in memory and retrieval. The average score for literal comprehension has improved, and there is a difference between pre-test and post-test. Mind maps use keyword extraction and hierarchical structure to visually classify facts, details, and order in texts. This enables students to quickly and accurately locate and extract information, greatly optimizing efficiency in memory and retrieval. The average score for literal comprehension has improved, and there is a difference between pre-test and post-test. This is where knowledge visualization theory is most effective. The implicit logical relationships in the text are abstract and difficult for students to understand. The lines, arrows, and spatial layout in mind maps make these invisible relationships visible . Therefore, the average score for interpretive comprehension has improved, and there is a gap of pre-test and post-test. To reach evaluative comprehension, readers are supposed to step out of the text and use personal values, external standards, and critical thinking to make judgments.

This is an activity that heavily relies on internal thought processes and non-textual information. Knowledge visualization serves the organization of internal information within texts, and it is difficult to effectively visualize students' personal value standards, broad background knowledge, and complex critical argumentation processes. So the evaluative comprehension remains the same, without any change.

In conclusion, mind maps are not omnipotent, but its role is precise and effective. It constructs visual relationships, effectively reduces cognitive load, acts as a scaffold for students to cross the "zone of proximal development", and significantly promotes the development of interpretive comprehension, a key ability. At the same time, it consolidates literal comprehension by optimizing information encoding. However, the comprehensive improvement of reading ability is a systematic project, and mind maps mainly serve the organization, understanding, and inference of information. However, their short-term impact on the evaluation level that relies on extensive knowledge accumulation and complex thinking habits, as well as the language threshold that determines ability levels, is limited. Therefore, regarding mind maps as a powerful classroom teaching aid rather than the only solution, integrating them into a long-term, comprehensive language teaching system can maximize their effectiveness.

Conclusion

This part is the last one of the thesis. The following findings were drawn: Through the analysis of the average score of three dimensions before employing mind map teaching, the students' overall level is evaluated as moderate, with literal comprehension as moderate, interpretive comprehension and evaluative comprehension as low. After using mind map teaching, the overall level of students remains the same - moderate, even though the value grows. The literal comprehension presents a moderate level, but interpretive comprehension jumps to a high level, from low to high. Evaluative comprehension still stays low. Through comparative analysis of the English reading scores before and after using mind maps, it was found that the latter showed a higher than the former in average value. At the same time, a significant gap was presented between the two. Furthermore, it suggests that students have higher average scores in both literary and interpretive levels, with a notable difference in them between pre-test and post-test. However, there's not a difference in evaluative comprehension between pre-test and post-test.

Based on conclusions, the recommendations below are hereby presented. Students' reading comprehension is limited as moderate at literal level. In order to improve it to a higher level, certain support or intervention are expected to be offered to boost their capabilities in the three dimensions. Mind maps are not omnipotent. Hence, the new teaching process should be explored in the long run. Teachers also need to practice the mind map based teaching, reflect and then continue to practice so as to integrate mind maps more perfectly with English reading teaching, truly resulting in the improvement of students' abilities, and better serving the classroom. Mind maps exerts a positive effect on English reading teaching. However, the mode of mind map based teaching are supposed to conform to closely, by highly organized class and properly arranged class

schedule. Moreover, teachers should pay attention to the cultivation of students' reading strategies and abilities in the teaching process.

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Conflict of interest

The authors declare no conflict of interest.

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