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การใช้ Electronic Mind Mapping ในการพัฒนาการอ่านเพื่อความเข้าใจของผู้เรียนไทย ระดับชั้นมัธยมศึกษาปีที่ 1

Using Electronic Mind Mapping in Improving Reading Comprehension of Thai EFL Seventh Graders

ชลดา นะราวัง[1] และพิลานุช ภูษาวิโศธน์[2]

Chonlada Narawang[1] and Pilanut Phusawisot[2]

คณะมนุษยศาสตร์และสังคมศาสตร์ มหาวิทยาลัยมหาสารคาม[1,2]

English Language Teaching Programme, Faculty of Humanities and Social Sciences, Maha Sarakham University[1,2]

Corresponding author, E-mail: chonda1996@gmail.com[1]

ABSTRACT

This study investigates the potential of utilizing electronic mind mapping (e-mind mapping) to enhance the reading comprehension of Thai EFL seventh graders. The impacts of the electronic mind mapping method on students' reading comprehension and their attitudes towards this approach were identified. The theoretical framework of the study drew upon the cognitive theory of multimedia learning (CTML), emphasizing the significance of multimedia materials combining visual and auditory elements in facilitating comprehension. The participants included 10 Thai EFL seventh graders from a school in Yasothon province, selected through purposive sampling from one intact class. Instruments employed for data collection included a pre-test and post-test for reading comprehension, an attitude questionnaire, a semi-structured interview, and lesson plans. Quantitative data from the pre-test and post-test for reading comprehension and the attitude questionnaire were analyzed using mean scores, *t*-test analysis, and standard deviation. Qualitative data from the semi-structured interview underwent content analysis. The study involved four phases: orientation, pre-test administration, treatment implementation, and post-test assessment. The results revealed a significant improvement in students' reading comprehension, with a *t*-value of 15.235, highlighting the effectiveness of electronic mind mapping. Furthermore, students displayed a high level of attitude towards the use of electronic mind mapping for improving their reading comprehension, as indicated by an average mean score of 4.68.

Keywords: Reading Comprehension, Electronic mind mapping, The Cognitive Theory of Multimedia Learning (CTML)

รับบทความ 2 มิถุนายน 2567 แก้ไขบทความ 30 มิถุนายน 2567 ตอบรับบทความ 9 กรกฎาคม 2567

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Introduction

Reading comprehension is a multifaceted process that involves both extracting and constructing meaning from written language. It goes beyond recognizing words on a page; it requires active engagement and interaction between the reader and the text (Grabe & Stoller, 2002; Snow, 2002; Meniado, 2016; Alyousef, 2005). In this process, the reader not only interprets the explicit meaning of the text but also acquires knowledge from it. They accomplish by decoding words, combining information, interpreting context, and making connections between different parts of the text, drawing upon their background knowledge and experiences (Manihuruk, 2020). It is not only about understanding individual words or sentences, but about grasping the overall author's intent and message. Mastering reading comprehension is crucial for learners as it directly impacts their ability to read proficiently and learn effectively. When students comprehend what they read, they can better conceptualize and understand the subject matter (Khanthawong, 2008; Roebl & Shiue, 2014). Furthermore, reading comprehension allows readers to create images or visualize the scenarios described in the text. This process of imagination enables a more immersive reading experience and facilitates a deeper connection with the material. Readers can see the story unfold in their minds, making the reading more engaging and memorable (Bormuth, 1966; Blair, Rupley, & Nichols, 2007; Hoeh, 2015).

However, EFL learners still encounter reading comprehension difficulties. Indeed, some researchers indicated that Thai EFL secondary school students demonstrate weaknesses in reading comprehension and are often incapable of understanding the reading texts (Chawwang, 2008; Sawangsamutchai & Rattanavich, 2016). Low scores on reading comprehension tests may be driven by several factors. For instance, students may not know the meaning of the new vocabulary or be unable to summarize the content correctly. They may also fail to use efficient strategies that help them understand and comprehend the reading texts. Teachers also primarily focus on grammar and vocabulary and may neglect the explicit teaching of reading comprehension (Chawwang, 2008; Chomchaiya & Dunworth, 2008; Sawangsamutchai & Rattanavich, 2016; Suebpeng, 2017; Samonlux & Yimwilai, 2020; Kamchorn et al., 2022; Monliang, 2022). The seventh graders in the current study also faced the same problems in reading as many Thai EFL learners. In their daily learning, they seemed uninterested in reading English texts. They also encountered difficulties in determining the mind idea. Consequently, they found it very difficult to get the meaning of passages they were reading, as shown by their low score in reading comprehension. Therefore, effective teaching methods are required to improve students' reading comprehension. Various strategies and methods have been proposed by many researchers to improve reading comprehension. Graphic representation is a recommended instructional strategy to improve reading comprehension. Graphic representations also known as graphic organizers help students organize and represent information from texts in a structured and visual format. Mind mapping is a type of graphic organizer and a visible drawing representing what happens in the process of storing information in the brain and can be used to generate ideas, take notes, organize thinking, and develop concepts (Buzan & Buzan, 1993; Ardini & Lashkarian, 2015). Mind mapping is also an effective tool for learners with low reading proficiency

(Mohaidat, 2018; Wangmo, 2018; Manotas, 2019; Morales et al., 2019; Saori, 2020; Al Shdaifat & Al-Abed Al-Haq, 2021; Al-Jarf, 2021; Yimwilai & Samonlux, 2020; Nisa & Novitasari, 2021; Kamchorn, 2022). However, using a mind mapping in its traditional form, in which students draw manually using paper and a pen or on the board, might not attract students in the 21st century. It has therefore been proposed that mind mapping should be combined with technology (Samonlux & Yimwilai, 2020). Electronic mind mapping is a new teaching technique for reading. It is a modern form of mind mapping created by specialized software (Aljaser, 2017) to help students draw a mind mapping. It is evident that many previous studies have focused on implementing mind mapping to improve reading comprehension of Thai senior high school students. However, more studies are needed to investigate the effect of electronic mind mapping on the improvement of Thai EFL seventh graders' reading comprehension. Indeed, by conducting the study to fill the aforementioned gap and investigating the effectiveness of electronic mind mapping with graphic images and collaborative strategies on improving reading comprehension among Thai EFL seventh graders, this current study was set out to use electronic mind mapping through Coggle.it to improve seventh-grade students' reading comprehension. Specifically, this current study aimed to (1) investigate the effect of the electronic mind mapping method on Thai seventh-grade students' reading comprehension and (2) examine students' attitude about electronic mind mapping and its ability to improve their reading comprehension skills.

Research Purposes

1. To investigate the effect of the electronic mind mapping method on Thai seventh-grade students' reading comprehension.

2. To examine students' attitude toward electronic mind mapping method.

Research Scope

Employing a mixed-method research design, this study aimed to investigate the effect of using electronic mind mapping on reading comprehension of Thai EFL seventh graders and to examine their attitudes toward electronic mind mapping. The participants were ten seventh graders, selected from one intact class, who studied the subject titled *Fundamental English* in the second semester of the academic year 2022. This school was an opportunity-extended school located in Yasothon province, Thailand. Four research instruments were used to collect data: a reading comprehension pre-test and a post-test, an attitude questionnaire, a semi-structured interview, and lesson plans. Teaching procedures included the implementation of electronic mind mapping combined with pre-reading, while reading, and post reading strategies. The duration of this study was five weeks.

Research Methodology

This study employed Mixed methods research, which involves gathering both qualitative and quantitative data. The current study used two phases to investigate the effect of electronic mind mapping on the

reading comprehension of Thai EFL seventh graders. A quantitative method was employed to collect and analyze the data from a reading comprehension pre-test and post-test and an attitude questionnaire. The qualitative method was employed to collect data from a semi-structured interview to gain a deeper understanding of complex phenomena and explore participants' perspectives.

Participants

This study was conducted at Songlaopo Wittaya School, an opportunity extended public school located in Yasothon province. Using purposive sampling within an intact class as selection criteria, the participants were ten seventh graders (five males and five females). Participants were 12 to 13 years old, and their native language (L1) was Thai. However, the students were considered to be at a beginner's level. To improve their English proficiency, all participants were required to enroll in the subject called *Fundamental English* in the second semester of the 2022 academic year which required students to understand basic words, sentences, and the main idea of reading texts.

Research Instruments

1. Reading comprehension pre-test and post-test were used to examine the participants' reading comprehension before and after the implementation of electronic mind mapping. The reading comprehension pre-test and post-test consisted of four short passages with 30 test items, which included 16 multiple-choice questions with four options for each question, 11 open-ended questions, and 3 cloze-test questions. Each question carried a value of 1 score, resulting in a total score of 30 scores. The reading passages were obtained from an educational website for EFL students. The same reading passages and questions were used for both the pre-test and the post-test. The test items were derived from the content of Grade 7th English passages that were also obtained from an educational website for EFL students. They included the following topics: Fast food, A Visit to the Water Park, Going fishing, and Students from Different Countries. The passages were appropriate for junior high school students and related to the Basic Education Core Curriculum B.E. 2008 determination of themes. Each reading passage included 100 – 150 words. All 50 items were examined by three experts to verify the content validity, using the Index of Item-Objective Congruence (IOC), with ratings for the reading comprehension test items ranging from 0.67 to 1.00. The difficulty index is 0.60 and the discrimination index is 0.26 and reliability is 89.2%. Based on these indexes, 30 items were selected for the actual pre-test and post-test.

2. Students' attitude questionnaire was administered after the treatment to examine the participants' attitudes toward the electronic mind mapping teaching method. The questionnaire comprises close-ended questions in response to the instructional strategy using electronic mind mapping. The attitude questionnaire consisted of 16 items with a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The questionnaire included two sections. The first section assessed students' attitudes toward the electronic mind-mapping teaching method after the treatment, and the second section included two open-ended questions that aimed to gather students' opinions on the treatment. Three experts were asked to examine and rate the validity of the questionnaire.

3. Semi-structured interview was used to obtain qualitative data to support the findings from the students' attitude questionnaire. Five participants were purposively selected to participate in the face-to-face interview since it can assess all participants' attitudes (Adams, 2015, p. 495), which included four open-ended questions. The interview was conducted in Thai after the treatment using an audiotape, and each interview took approximately three minutes.

4. Lesson plans were used to instruct participants in reading comprehension, incorporating the learning standards and indicators for the seventh-graders as outlined in the Basic Education Core Curriculum (The Ministry of Education, 2008). It consisted of four lesson plans, conducted over a total of eight hours. The topics covered in the lesson plans were Mother's Day, Bicycles, Ice Cream, and Medicinal Drugs.

Data collection

To achieve the purposes of the study, the following procedures were implemented:

1. The participants were received a class orientation. All participants were informed of the concept of electronic mind mapping, which denotes an online graphic organizer utilized to create visual representations of information, purposes of this study, the research procedure, and the benefits of using electronic mind mapping. The teacher informed students about an online platform for creating mind mapping, which was www.Coggle.it. Besides, the participants' parents were asked to submit the ethical consent form.

2. The pre-test was administered to examine participants' reading comprehension before implementing electronic mind mapping.

3. Participants underwent instruction through four lesson plans, structured across three stages of teaching reading: pre-reading, while-reading, and post-reading activities. The lesson plans covered topics which are Mother's Day, Bicycle, Ice cream, and Medicinal drugs. The study consisted of two phases, comprising four steps: planning, acting, observing, and reflecting. The first phase served as a pilot stage to address practical concerns, while the second phase focused on developing a teaching method based on reflections from the first phase.

After the treatment, the participants took the reading comprehension post-test. The test included the same set of reading passages and questions as the pre-test, and the duration was one hour. The participants were assigned to complete the attitude questionnaire to assess their attitude towards the electronic mind mapping method. Finally, five participants were purposively selected to participate in a semi-structured interview. The face-to-face interview was conducted in Thai to avoid any language barriers. The interview was recorded and transcribed.

Data analysis

The data obtained from the pre- and post-tests underwent analysis through dependent *t*-tests, while the data gathered from the attitude questionnaire were analyzed using standard deviation and mean, interpreted according to the criteria from Best (1981). The following range of mean scores were used to interpret the findings: Very high = 4.50-5.00, High = 3.50-4.49, Average = 2.50-3.49, Low = 1.50-2.49, and Very low = 1.00-1.49. The qualitative data gathered from the semi-structured interviews underwent analysis through content analysis.

Results

The following sections presents the findings of the study and explains how they relate to the two research questions.

1. The effect of electronic mind mapping method on Thai EFL seventh graders' reading comprehension.

Research Question 1: To what extent does the electronic mind mapping method affect Thai EFL seventh graders' reading comprehension?

Table 1 A summary of students' reading comprehension

	N	$\bar{x}$	S.D.	t	P (Sig.)
Pre-test	10	3.50	1.581	15.235	.000
Post-test	10	17.90	2.601		

Note: Significant at the 0.01 level ($p < 0.01$)

Table 1 presents a statistical summary of students' reading comprehension. In this study, a one-tailed hypothesis test was used to analyze the data. The p-value, which is reported as .000, indicates a statistically significant difference between the mean scores of students in the reading comprehension pre-test and post-test at the 0.01 significance level, ($t=15.235$, $p<0.01$). The mean scores of reading comprehension pre-test are 3.50 (S.D. = 1.581), whereas the mean scores of reading comprehension post-test is 17.90 (S.D. = 2.601). It indicates that electronic mind mapping improves students' reading comprehension, as shown in the post-test score, which is higher than the pre-test score.

2. The students' attitude about electronic mind mapping in regards to improving reading comprehension.

Research Question 2: What is the students' attitude about electronic mapping in regards to improving reading comprehension?

The students' attitude questionnaire included two aspects: electronic mind mapping and reading comprehension strategies, which were both addressed by the closed-ended and open-ended questions. The students rated on a 5-points scale ranging from strongly disagree to strongly agree. Based on Best (1981), the following range of mean scores were used to interpret the findings: Very high = 4.50-5.00, High = 3.50-4.49, Average = 2.50-3.49, Low = 1.50-2.49, and Very low = 1.001.49. The aspect 1 of the students' attitude questionnaire was purposed to investigate students' attitude toward the use of electronic mind mapping on improving seventh graders' reading comprehension. In the aspect 2 questionnaire, students were required to respond the four items which were close-ended questions in order to investigate respondents' attitude toward the use of two reading comprehension strategies adopted in the reading comprehension class: graphic organizers and collaborative strategy. The results of the questionnaire are revealed in Table 2.

Table 2 Students' attitude towards the use of electronic mind mapping in reading comprehension

	Aspects	$\bar{x}$	S.D.	Results
1	Electronic mind mapping	4.65	0.47	Very high
2	Reading comprehension strategies	4.75	0.43	Very high
Total		4.68	0.46	Very high

From Table 2, the aspect 1 shows the mean score is 4.65 with a standard deviation of 0.47 and the aspect 2 shows the mean score is 4.75 with a standard deviation of 0.43. It shows that the aspect 2' s mean score has a higher score than the aspect 1. Hence, it indicates that seventh-grade students appreciate the use of graphic

organizer and collaborative strategies in reading comprehension learning. However, the overall mean scores of the students' attitude questionnaires are at a very high level, with a mean score of 4.68, a standard deviation of 0.46. It indicates that seventh-grade students have positive attitudes with the use of electronic mind mapping to enhance their reading comprehension.

3. The students' attitude about electronic mind mapping in regards to improving reading comprehension: Semi-structured interview

The current section is presented to address the second question and to corroborate the findings from the students' attitude questionnaire. All respondents agreed that implementing electronic mind mapping for improving their reading comprehension was an effective approach since it provided an exciting teaching method and encouraged them to analyze the stories and identify the main idea, which they thought it was difficult. These are the instances from the data.

"It was a good teaching method because I was able to understand English story through creating mind mapping." (Respondent 2)

"It encourages me to read since I could understand the passages and identify the main idea." (Respondent 3)

"I think it effective to me because I was able to comprehend the passages." (Respondent 4)

"I think it was a good method because it reduced boredom in English class since it was a unique way of teaching that I had not experienced before and because I was permitted to use a computer in reading class." (Respondent 5)

All respondents also found that studying reading comprehension using electronic mind mapping was enjoyable and helped them keep themselves more involved in their English classes since it offered them access to an interesting online platform as well as provided them with the motivation to search for images to add to their mind mapping.

"I think it was a good method because it reduced boredom in English class and allowed me to study English using an online platform and I could design my e-mind mapping with my classmate and search some pictures to decorate our mind mapping." (Respondent 1

"I enjoyed using E-mind mapping in class since I could design it with helpful features on the web platform, such as having to use different colors to distinguish each sub-topic." (Respondent 2)

"I enjoyed implementing this method since it was a unique way to teach that attracted my attention." (Respondent 3)

"I think it was a good method because it reduced boredom in English class since it was a unique way of teaching." (Respondent 4)

"It reduced boredom in English class since it was a unique way of teaching that I had not experienced before and because I was permitted to use a computer in reading class. This e-mind mapping platform provided me with interesting features such as adding pictures, changing the colors of lines, and changing shapes." (Respondent 5)

Three respondents found graphic organizers helpful in organizing information and enhancing their comprehension of stories.

"The graphic organizers provided subtopics for dividing the information into smaller groupings, they made it easy for me to summarize the passages." (Respondent 2)

"It helps me to summarize information because it enabled me to express my ideas through it and I could answer the questions from those passages." (Respondent 4)

"It helps me organize my information from texts as well as understand the passages with simplicity." (Respondent 5)

Additionally, three respondents are able to communicate with others in their group to clarify any complicated information when they were having trouble comprehending the information from the stories they were reading.

"I was able to brainstorm with classmate, it helps to increase my reading comprehension since I can focus on the story's keywords and importance details." (Respondent 2)

"I found that discussing the passages with my friends and creating our mind mapping together had helped me understand them better." (Respondent 3)

"I could collaborate with classmate for sharing information from the passages when I found it complicated." (Respondent 4)

On top of that, three respondents reported that they accepted that using this teaching method had improved their reading comprehension and their ability, to sum up the main idea of a story. They require the teacher to use this method in future reading classes.

"I want the teacher to implement the e-mind mapping method in the next class." (Respondent 1)

"I found it was effective for me, and I hope teacher keep using this approach to instruction." (Respondent 2)

"This type of teaching helped me organize information from the texts and was exciting, I was able to understand the passages with simplicity. I hope the teacher will implement this method in the following classes." (Respondent 5)

Although many respondents revealed positive attitude about electronic mind mapping method however using electronic mind mapping method could be time-consuming and difficult for two respondents.

"I think it was difficult and took times at the first time" (Respondent 1)

"The first time I studied reading comprehension through E-mind mapping, I found it was difficult, but in the end, I found it was effective for me." (Respondent 2)

In conclusion, all respondents had positive experiences with implementing electronic mind-mapping method and found it beneficial for improving reading comprehension and encouraging creativity. The use of electronic mind mapping allowed them to effectively summarize and consolidate their understanding of the stories or passages they read. Furthermore, the collaborative strategy employed by the respondents contributed to their improved comprehension. Collaborative learning encourages active participation, discussion, and the sharing of different perspectives, which can deepen understanding and expose individuals to new insights. By working together on mind-mapping activities, the respondents likely benefited from the collective knowledge and perspectives of their peers, enhancing their comprehension even further.

Discussion and Conclusion

1. The effect of electronic mind mapping on students' reading comprehension

Based on the pre-test and post-test results, the students' reading comprehension significantly improved

after learning through electronic mind mapping to improve reading comprehension at the 0.01 level. Furthermore, the post-test scores ($\bar{x}$ =17.90) were found to be significantly higher than the pre-test ($\bar{x}$ = 3.50). This indicated that the students' reading comprehension improved after learning through electronic mind mapping. The reading comprehension post-test scores improved from the pre-test scores due to a few reasons. Firstly, electronic mind mapping represents an application of the cognitive theory of multimedia learning (CTML). Electronic mind mapping involves the use of graphic organizers that incorporate graphic images, serving as visual aids that can assist students in constructing visual representations of the information contained in the texts they have read (Alkhasawneh et al., 2013; Abdul Samat & Abdul Aziz, 2020). When students were presented with both images and text, they would actively choose which ones to store in their working memory as students typically have a restricted capacity to hold a limited amount of textual information (Paivio, 1986). Consequently, the use of electronic mind mapping could aid them in structuring words, text, and graphical images into a cohesive mental framework. This facilitated their ability to integrate these materials with their prior knowledge to comprehend the information. The students' excerpts are as follows:

"I could design my e-mind mapping with my classmate and search some pictures to decorate our mind mapping." (Respondent 1)

"I enjoyed using e-mind mapping in class since I could design it with helpful features on the web platform, such as having to use different colors to distinguish each sub-topic." (Respondent 2)

"This e-mind mapping platform provided me with interesting features such as adding pictures, changing the colors of lines, and changing shapes." (Respondent 5)

Utilizing electronic mind mapping as a graphic organizer serves as a visual aid for students. In this study, students were tasked with creating mind mapping that incorporated graphic elements. This approach enhanced students' understanding of the components of reading texts once they had completed their mind mapping. This is because of combining textual and visual elements can activate various cognitive processes and promote a more profound grasp of the texts (Mayer, 2005). The following excerpts support the findings:

"The graphic organizers provided subtopics for dividing the information into smaller groupings, they made it easy for me to summarize the passages." (Respondent 2)

"It helps me to summarize information because it enabled me to express my ideas through it and I could answer the questions from those passages." (Respondent 4)

"It helps me organize my information from texts as well as understand the passages with simplicity." (Respondent 5)

Hence, the utilization of electronic mind mapping may facilitate students in retaining information in their long-term memory since students receive visual content through their eyes, and when presented with relevant images related to the reading texts, students can potentially form a comprehensive mental picture of the content from the reading texts. The finding regarding the effectiveness of electronic mind mapping as graphic organizers on improving reading comprehension aligns with the study of Mohaidat (2008), who claimed that

electronic mind mapping had an impact on students' reading comprehension since it provided a tool for graphic images and encouraged students to retain passages more effectively. The findings also align with previous studies, which revealed that electronic mind mapping and graphic images helped students improve their reading comprehension (Sam & Rajan, 2013; Aljaser, 2017; Morales et al., 2019). Students were able to visually represent the connections and relationships between different ideas and concepts within the passages since visual display helped in organizing information. They allowed students to see the overall structure and main points of the text, facilitating a deeper understanding.

Another explanation of students' improvement in reading comprehension may be based on the reading stages used in this study. This current study included pre-reading, while-reading, and post-reading. The pre-reading stage aimed to familiarize students with the vocabulary related to the passages and develop their understanding of sentence structures. A vocabulary game was implemented, which actively engaged the students and facilitated their acquisition and retention of new vocabulary. This game included relevant pictures alongside the text, a strategy that could enhance students' ability to grasp and remember the vocabulary words. During the while-reading stage, both the teacher and students read the passages aloud. Following the reading, students were tasked to scan the passages to locate the vocabulary they had previously learned. Students could enhance their understanding of the sentences and overall passage meaning by applying the vocabulary in context. In the post-reading stage, which was considered the most critical stage, students had to brainstorm with their friends to discuss information about the passages. Then students were assigned to create an electronic mind mapping to summarize the passages. Students' reading comprehension was enhanced by completing the e-mind mapping activity in the post-reading stage. Summarizing the information and creating visual representations of the passages encouraged students to organize their thoughts and identify important information. This activity also allowed students to review and reinforce their understanding of the passages, leading to improved comprehension. The finding is in line with Al-Jarf (2021), who stated that using electronic mind mapping in the post-reading stage helped students comprehend the texts. This finding is also in line with the study of Monliang (2022), which reported that using electronic mind mapping in the post-reading stage helped students to comprehend the reading passages better. In addition, the findings are also consistent with previous studies which asserted that electronic mind mapping was useful and effective as the post-reading activity to review the reading passages (Siriphanich & Lohawiriyanon, 2010; Samonlux & Yimwilai, 2020; Phongploenpis & Supangyut, 2018). Moreover, using the collaborative strategy while reading might improve their reading comprehension. This study encouraged students to exchange information and discuss difficult parts of the passages with their classmates. This collaborative environment fostered others to learn, where students could benefit from diverse perspectives and insights. It also encouraged active engagement with the passage and promoted deeper comprehension. This is in line with Hazaymeh & Alomery (2022), who supported the idea that students can enhance their reading comprehension through activities such as brainstorming and creating associations between the main ideas, supporting ideas,

and the conclusion of a given text. These strategies promote active engagement with the text and help students organize their thoughts effectively. The finding also aligns with the study of Chaichompoo (2017), which supported the notion that collaborative strategy was effective in fostering students' individuality by providing an opportunity for useful discussions and knowledge generation within a group. Moreover, previous studies were also reported that brainstorming as a collaborative strategy encouraged students to create electronic mind mapping and comprehend the reading passages easily (Malekzadeh & Malekzadeh, 2015; Sabbah, 2015; Samonlux & Yimwilai, 2020). The following excerpts support the findings:

"When I brainstormed with classmates, it helped increase my reading comprehension since I could focus on the story's keywords and important details." (Respondent 2)

"I found that discussing the passages with my friends and creating our mind mapping together helped me understand the reading passages better." (Respondent 3)

"I collaborated with classmates to share information from the passages when I found them too difficult to understand." (Respondent 4)

2. Students' attitude towards the implementation of Electronic mind mapping in Improving Reading Comprehension

In response to Research Question 2: What is the students' attitude about electronic mind mapping in improving reading comprehension? Students' attitude questionnaire was administered to examine their attitude towards electronic mind mapping. A semi-structured interview was also conducted to obtain their attitude of using electronic mind mapping to improve reading comprehension. The students' attitude questionnaire results indicated that students showed their attitude towards electronic mind mapping at a very high level, with a total mean score of 4.68. Based on the questionnaire results toward aspect 1: electronic mind mapping, it can be inferred that seventh-grade students showed their attitude at a very high level with the use of electronic mind mapping to enhance their reading comprehension with a mean score of 4.65. The participants responded that the electronic mind mapping was interesting, useful, and effective. It also helped them comprehend the reading texts better, was easy to use, helped them identify the reading texts' main idea and key elements, helped them remember details and summarize them, and helped them answer questions. They perceived that electronic mind mapping helped them understand through drawing inferences, helped them draw connections between prior knowledge and the new information, helped them understand the stories better and helped them understand how to create an electronic mind mapping.

Limitation and recommendations

1. A one-group pre-test and post-test design may not provide a strong basis for determining the effectiveness of employing electronic mind mapping. Future research may include a two-group experimental design with an experimental group that employs electronic mind mapping and a control group that does not would be beneficial. This would provide stronger evidence of the effects of electronic mind mapping on students' reading comprehension. By using a control group, researchers can compare the outcomes of students who use electronic mind mapping with those who do not, which helps establish a baseline for comparison.

2. Most students revealed their positive attitude of electronic mind mapping in improving reading comprehension at a very high level. However, some students responded in a semi-structured interview that electronic mind mapping could be difficult and time-consuming. Future research may consider extending the training duration from one hour to three hours to ensure students truly understand how to design an electronic mind mapping. This extended training duration would allow for a more comprehensive understanding of the tools and techniques involved, which could ultimately enhance the effectiveness of electronic mind mapping as an educational tool.

3. This study only used computers to train students to design an electronic mind mapping, future researchers may include other teaching materials to help students understand the concept faster, such as tablets, worksheets, YouTube, and mobile applications.

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