Digital Cartography of Thought: Enhancing EFL Reading Comprehension Through Mind Mapping

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Abstract

Current educational research focuses on classroom instruction and employing technology to improve learning. This research proposes Digital Mind Mapping with Collaborative Learning in the fourth semester of the English department curriculum. This research investigates the possibility of using Digital Mind Mapping, combined with Collaborative Learning, to enhance academic performance in students. The data on these issues is collected by implementing a research project incorporating mixed methods research. The research comprises interviews with teachers and students currently enrolled in the English Department Programme at Universitas Jabal Ghafur and firsthand observations on their classrooms. In addition, both pre and post-tests will be conducted. This study demonstrates that cognitive talents and traits affect the efficiency of Digital Mind Mapping with Collaborative Learning as an educational tool. The presence of these attributes and educational competencies has positively influenced the academic achievement of students. The study also identified many challenges educators and learners have when incorporating Digital Mind Mapping and collaborative learning approaches into their educational settings. This research emphasises the need to modify educational approaches in education, particularly for the purpose of English language acquisition. It evaluates the degree to which this tactic might enhance these methodologies.

Keywords: Integrating; Digital Mind Mapping; Collaborative Strategy; Learning Process.

Much modern education research has focused on classroom teaching and learning, especially how technology supports education. The digital revolution has created smart pupils who desire the best education. The blend of conventional and digital approaches, depending on the learner's requirements, is essential to the learning process. Bhattacharya, D., & Mohalik, R. (2020) state that children acquire the status of digital 'natives' due to their early exposure to technology. As a result of changes in the information environment, the way this new generation interacts and perceives the world has been influenced, and they need a new learning method (Bhattacharya & Mohalik, 2020). This research analyses how Digital Mind Mapping aids Collaborative Learning. This study examines how Digital Mind Mapping might improve Collaborative Learning by encouraging group engagement. The project intends to show that digital mind mapping and collaborative learning improve reading comprehension across digital literacy levels. This research is necessary because it investigates if innovative teaching approaches, such as Digital Mind Mapping, might improve the educational system, particularly in English Classes. As a lecturer and researcher, I've seen the Indonesian Ministry of Education's support for Collaborative Learning. Unfortunately, many lecturers lack Collaborative Learning abilities, which might restrict its influence on their teaching.

Collaborative Learning using ICT, such as Digital Mind Mapping, is promoted because students find it engaging and participatory. The institution has computer technology, but it is unclear whether lecturers utilize it collaboratively and interactively or need further training. This significant issue deserves more investigation (Chang et al., 2018; Chen, 2017; Huong et al., 2021).

This research combined qualitative and quantitative methodologies. Interpretative philosophy-based qualitative and quantitative methodologies yielded considerable case study data. Mixed methodologies including direct classroom observations and lecturer and student interviews, clarified empirical results. This research examines whether innovative teaching techniques, such as Digital Mind Mapping, positively affect Indonesia's educational system's growth. Nevertheless, a prevalent problem arises from instructors' insufficient proficiency in ICT, restricting the effectiveness of utilising digital mind mapping to improve the quality of their teaching. The endorsement of an appropriate pedagogical approach using Information and Communication Technology (ICT), such as Digital Mind Mapping, primarily relies on the premise that it is an engaging and participatory method of instruction for students

To accomplish the objectives of the investigation, the study formulates the following research question:

1. How does Digital Mind Mapping support the learning process?
2. How do learning results differ between an experimental group using digital mind mapping and collaborative learning against a control group not using these methods?

Literature Review

Mind Maps

Digital mind mapping, a very effective visual technique, has become more popular in educational and professional settings. It is a flexible method used by persons with different digital skills (Jbeili, 2013; Meyers et al., 2013; Vejayan & Md. Yunus, 2022). Digital literacy comprises diverse abilities and competencies, including the capacity to understand and use digital technology and the critical thinking and creativity needed to harness these resources successfully. It is crucial to note that digital literacy includes essential abilities such as critical thinking, creativity, and innovation. These skills are necessary for people to use digital tools and resources to their maximum potential effectively (Z. Zhang, 2023). In an era of growing digitalization worldwide, the significance of digital competence has become crucial. The COVID-19 pandemic has expedited this trend and emphasized the need for higher education to prioritize cultivating digital literacy alongside conventional academic literacies. Nevertheless, incorporating digital mind mapping and its availability to individuals with varying degrees of digital literacy is still being investigated and studied. Poore's claim that achieving collective liberating intelligence is contingent upon attaining collective digital literacy underscores the need to comprehend how people with diverse digital skills may meaningfully participate in and benefit from digital platforms (Karim & Mustapha, 2020;Amumpuni et al., 2023;Lestari et al., 2024).

"Digital Literacy," defined by Eshet, refers to the capacity to effectively navigate and adapt to the digitally-oriented environment using cognitive, sociological, and emotional skills. It is important to note that digital literacy extends beyond mere proficiency in using digital devices or software, as users must possess a range of cognitive, emotional, and sociological abilities to engage with the digital environment effectively" (Abd. Karim et al., 2023). Furthermore, acknowledging that digital literacy is not limited to being a skill taught in schools but rather a complex set of abilities that are nurtured and cultivated in different informal learning settings, such as libraries, museums, and online communities, emphasizes the necessity for a more all-encompassing approach to digital literacy education. By acquiring the essential digital skills, people may use digital mind-mapping techniques to enhance their learning process, problem-solving, and decision-making abilities, irrespective of their initial level of digital literacy (Karim & Mustapha, 2020;Abd. Karim et al., 2023). As higher education institutions focus on incorporating digital literacy into their main curriculum, it is important to investigate further and explore the relationship between digital mind mapping and varying degrees of digital literacy. The interaction between these factors may facilitate the discovery of novel and creative methods for education, acquiring knowledge, and individual growth in the era of digital technology. People with various degrees of digital skills may use digital mind mapping differently, using its flexibility to improve their cognitive capacities, problem-solving skills, and decision-making abilities (Sari et al., 2021). Investigating how individuals with varying levels of digital literacy may successfully use digital mind mapping might result in more inclusive and accessible educational experiences, enabling all learners to succeed in the more digitized environment (Sari et al., 2021;Yan & Kim, 2023).

Investigating and examining digital literacy levels is an essential domain that requires more study and exploration. This field has the potential to reveal novel and inventive methods for instructing, acquiring knowledge, and personal growth in the era of digital technology (Gibson & Smith, 2018). This section discusses three Mind Map definitions. Mind Mapping, as defined by its creator Buzan, is a manifestation of Radiant Thinking and hence a cognitive process of the human mind. The visual technique used is very effective in unlocking the brain's potential on a global scale (Debbag et al., 2021).

Figure 1. Brain Cells

Buzan claims that a Mind Map's neural network connections encourage learners to use more of their brain since it mimics the human brain (Buzan, et al., 2013) (see Illustration in figure 1 above). Abd Karim (2020) suggests that Mind Mapping may connect knowledge from many sources, utilising images and phrases to map data. It can also summarise an entire chapter on one sheet of paper. Mind Mapping helps the mind produce, organise, and convey ideas (Abd. Karim et al., 2023). Since Mind Mapping helps promote and organise thoughts and summarise others' ideas in talks, presentations, and meetings, it has much to offer. Gibson (2018) states, “The brain does not inherently operate linearly or rely only on memorising word lists to gain language. He said that educators at all levels know the significance of using contextual information to help comprehend word meanings” (Gibson & Smith, 2018).

Thus, digital mind mapping may help learners self-regulate by organising information that resembles the mind. This finding confirms that the self-regulation of structured activities enhances student performance. It was discovered that socially organized self-regulation occurs when students coordinate their learning and engage in collaborative groups. The social framework enables collective regulation, hence promoting student self-regulation. Furthermore, Solanki et al. (2019) illustrate how students might use mind maps to establish metacognitive connections between topics. According to the Bloom Taxonomy, mind maps let students examine and connect prior and new material, which enhances higher-order cognitive skills (Chalak & Rastgoo, 2021; Wang, C. H, 2020).

He also showed how mind mapping improves second language acquisition for ESL/EFL students by encouraging creative thinking and knowledge retention. Mind Maps, as metacognitive tools, may assist Bloom's taxonomy's more sophisticated cognitive levels. Wang (2020) discovered that Mind Maps significantly impacted the development of Bloom's Taxonomy's higher-level cognitive abilities. Mind Maps improved pupils' analysis and connection to new and old material. Creating a Mind Map requires analysis, which involves breaking down complicated information and establishing links. Digital Mind Maps have several benefits in education, as shown by Yan and Kim (2023), who saw them as a tool to take notes. Thought maps also assist professors in providing students feedback by showing their thought structures (Mancao & Dequito, 2022). Thus, Mind Maps help students show and connect points, which is essential. However, since Mind Maps are personal representations, others may not always understand them as the author intended. Thus, defining how Mind Maps might support educational aims is difficult. Previous definitions of mind mapping emphasize its capacity as a learning tool, but it is also essential to grasp its practical use. This will help you understand how Mind Mapping allows students.

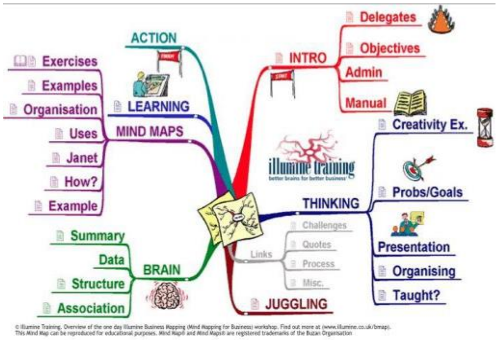

Figure 2. Digital Mind Mapping Example

Various mapping frameworks, Idea maps and mind maps, both of which are extensively used and researched in the realm of education, have been created and are often employed. This particular section provides a comprehensive overview of their research experience and expertise. Joseph Novak and his colleagues at Cornell University developed Concept Maps in the early 1970s to examine the evolution of children's scientific comprehension (Karim & Mustapha, 2020). Based on constructivist theory and influenced by Jean Piaget's work, David Ausubel's learning psychology posited that learning occurs when new ideas and propositions are integrated inside the learner's pre-existing cognitive structures and mental representations. Concept Maps use connecting words and propositions to display clear links between concepts hierarchically or relationally. Mind Maps mimic human cerebral circuits (Buzan, 2024). Mind Maps' informal structure and ease of usage may make them more accessible for beginners than Concept Maps, which show propositional connections and require longer understanding. On the other hand, concept maps are easily understood by others, whereas Mind Maps are generally more personal. Nevertheless, the Mind Map enhances learning outcomes by linking concepts with symbols and pictures, facilitating better retention and flexibility (Winata & Rahmat, 2022). Mind mapping may help pupils succeed academically, according to

Rafidah (2020). This intriguing alternate method may reveal more about this research and how it can improve academic performance. It discovered that despite mind maps being a strategy and instructional technique, research is scarce on utilizing mind maps by children in educational settings.

Digital Mind Mapping and Learning

This research will extensively examine software-based Digital Mind Mapping in this area. Educators have recently emphasized the role of computers in education, resulting in a worldwide increase in Computer-assisted instruction and learning. New computer-based teaching approaches, such as DMMs, are helping to reach several Objectives related to the curriculum, students, and education. Several computer software provide digital mind mapping, a practical approach to preserving knowledge for editing and development. Digital Mind Maps may include pictures. An example of a computer-based program is iMind Map, developed by Buzan (2024) at http://www.tonybuzan.com/

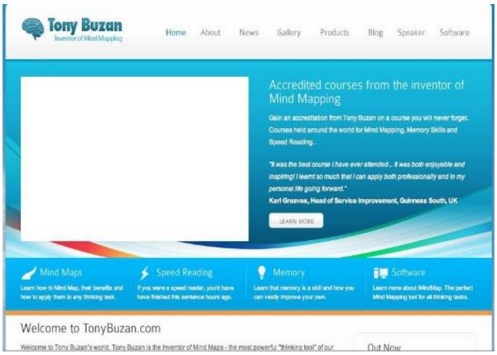

Figure 2. Tony Buzan Website iMindMap is its programme download: https://imindmap.com/software/

Figure 3. IMindMap Software

During the last several years, there have been significant advancements in education, including a rapid increase in knowledge, improved access to information, and widespread use of technology. Both scientific and pedagogical technology have been used to assist teachers in creating and enhancing lessons. Yan & Kim (2023) say digital mind maps are effective in all domains since they graphically show essential ideas. Technology has digitalised Mind Mapping. Vejayan & Md. Yunus (2022) discovered that mind-mapping computers boost class creativity by encouraging student collaboration and inventiveness. Students may study more interactively and actively by being creative and using technological tools like Digital Mind Maps to communicate their thoughts. It suggests that digital Mind Mapping may increase academic achievement over hand-drawn. As expected, more studies are being done on the advantages of computerized mind mapping in several educational fields. Winata & Rahmat (2022) found that mind-mapping training improved reading comprehension in EFL Classes. The kids liked using this software and indicated they would use it again, although they required more practice. The survey also found that a shortage of the incorporation of technology and provision of laptops for each student obstructs this goal (Winata & Rahmat, 2022). Another research study found that DMMs outperformed paper-based mind maps, mainly in classroom activities like brainstorming student discussions (Tinmaz et al., 2022;Coffin Murray et al., 2022;Vega et al., 2020; Wang, 2020). This digital technology includes the Digital Mind

Map, which has various smart device apps. In this research, students collaborated by utilizing iPads using mind map apps like iMindMap.

Collaborative Learning

In recent years, a growing focus has been on incorporating collaborative learning practices in English language classes. Collaborative learning, based on the principles of social constructivism, is a very successful method in language acquisition (Zhang, 2023;(Huong et al., 2021);(Handayani et al., 2019);(Hidayati et al., 2019); Chen, 2017; Veramuthu & Shah, 2020). Collaborative learning entails the participation of small student groups that collaborate to achieve a common objective, participating in intentional conversations to resolve issues.

Collaborative learning effectively improves students' language skills in an English as a Second Language classroom. Research has shown that engaging in collaborative learning not only enhances students' listening and communication skills, but also fosters their overall language acquisition. The incorporation of technology has played a significant role in changing teaching approaches. Various technological tools and platforms have made it easier for students to collaborate and become more engaged in activities related to reading, writing, and other language skills (Z. Zhang, 2023).

Collaborative learning in the English classroom has a significant advantage in enhancing students' writing abilities. Through collaborative efforts in small cohorts, students may actively participate in peer evaluation, provide constructive criticism, and raise the quality of their written assignments, so improving their writing skills. Moreover, the interactive and dynamic characteristics of collaborative learning provide an atmosphere that is favourable for language practice and the enhancement of skills (H. Zhang et al., 2019). Nevertheless, the efficacy of collaborative learning in the English classroom relies not only on the technique itself. Instructors' attitudes and implementation tactics are essential in influencing the effectiveness of collaborative learning. Hence, educators must acquaint themselves with collaborative learning methodologies and integrate them into their instructional approaches in a manner that optimally facilitates their students' language acquisition objectives (Murad et al., 2021;Huong et al., 2021;Chen, 2017;Koşar, 2023).

Method

The researcher used a comprehensive interpretative approach using mixed methods research to leverage the distinct benefits of qualitative and quantitative methodologies. Combining diverse approaches was advantageous since it mitigated certain limitations associated with individual instruments.

Data Collection

Data was collected using qualitative approaches like classroom observation, semi-structured interviews, and quantitative methods used tests to answer the questions of the research problem.

Data Analysis

In qualitative analysis, the researcher used an observation checklist and semi-structured interview after that description to give the data results. Quantitative data analysis is important in evaluating and comparing the advancements in the academic performance of the experimental and control groups were compared by analysing their pre-test and post-test results. The SPSS Tool was examined for analysis. The examinations were graded and the results were documented. Subsequently, suitable statistical tests were used. This research was conducted To conduct an investigative or preliminary examination analysis of the quantitative effect rather than aiming to establish a definitive conclusion.

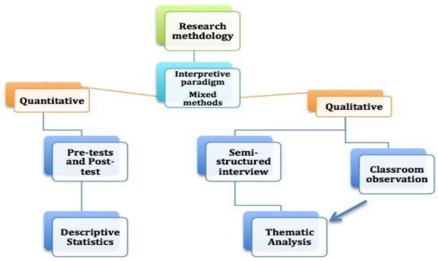

Figure 4. Diagram of Research Method

Results and Discussion

How does Digital Mind Mapping support the learning process?

The findings for schools in a comparable setting are very similar. As a result, there has been a rise in utilising Collaborative Learning and Digital Mind Mapping (CLDMMs) in Reading Comprehension classes. Students have reported an increase in their level of involvement, particularly during group activities. The researcher's findings have further supported this observation. Furthermore, instructors saw a disparity in results between the control and experimental classes.

In contrast, the researcher observed that under the conventional technique, pupils would engage in class activities for the first five minutes but rapidly lose concentration unless the instructor used other instructional approaches. The teacher's records corroborated this finding. Occasionally, these courses were more subdued than those using CLDMM; the pupils had become used to studying monotonously. The decrease in attention may be ascribed to the teacher's failure to recognize the importance of students' dual learning needs as individuals and as group members.

Conversely, in the control group (utilising the conventional technique), students experienced a loss of focus. They expressed dissatisfaction with the limited chance to engage and exchange ideas with their peers after 15 minutes of the class. The students also conveyed that they had difficulty discerning some teachings due to the similarity in the concepts offered. The instructor corroborated this, noting that several kids achieved subpar results on the exam. The instructor also had challenges communicating the concepts effectively to students, suggesting that group learning facilitated content comprehension. Furthermore, the time required for lesson preparation was extensive to ensure students comprehended the knowledge within a constrained timeframe, only to forget the crucial aspects.

Despite the teacher's efforts to apply multiple teaching approaches, the control class kids were bored. Nevertheless, student involvement was still lower compared to the CLDMM classrooms. According to one student, the instructor dominated most of the session as the only speaker, resulting in less contact and restricted discussion. This lack of student interest led to a lack of participation. A student proposed that classroom interaction may be influenced by the student's interests and level of involvement with relevant topics. Occasionally, students only became actively involved with the content towards the conclusion of the course, primarily whether they were driven by the possibility of resting or starting the next lesson.

Collaborative Learning allows students to engage in peer-to-peer interaction and collaboration via workshops to achieve a satisfying solution. Students have observed that cooperation is essential for effective learning and motivates them to participate actively. Several students have reported that group learning is more efficient than solo learning since it allows faster task completion via Digital Mind Mapping. Additionally, group learning may enhance the interpersonal relationships among students. The instructor saw that incorporating students with varying levels of ability in Collaborative Learning resulted in higher levels of achievement. At the third school, pupils were enthusiastic and motivated to be early for class if they lacked proficiency in utilising technology for Islamic Education. These methods made courses more appealing, fostering increased retention and drive.

According to the instructor, the control class, which mainly engaged in solo learning, showed reduced levels of learning interaction and desire to learn compared to the experimental class. A student claimed that individual learning resulted in the instructor being the only provider of knowledge, leading to a limited understanding of their ideas and opinions on the course. While CL enhanced the material and provided students with more opportunities to articulate their viewpoints, it required effective supervision by the instructor over the students. The researcher suggests that the learning experience in the control classroom may have been more thorough due to its reliance only on the textbook and instructor. However, CLDMM provided a more immersive and enriching setting. This viewpoint was reinforced by a student who expressed that the traditional approach did not foster the development of his critical thinking skills.

Surprisingly, I saw more significant levels of conduct and self-control in the control courses compared to the CLDMM sessions. Nevertheless, one student voiced a predilection for solitary studying and commended this approach, which engendered a greater sense of ease than engaging with others. Teachers may eventually use a combination method of learning that may be done alone or in collaboration with others tailored to the particular needs of their students, gradually departing from conventional teaching practices.

How do learning results differ between an experimental group using digital mind mapping and collaborative learning and a control group not using these methods?

Pre-test and post-test scores in both the Experimental Class and Control Class

Table 1. Total count of students in both pre- and post-tests

Total student count				
Control Class		**Experimental Class**		
Pre-test	**Post-test**	**Pre-test**	**Post-test**	**Total**
30	30	32	32	124

The test marks' dependability was verified by measuring the pre-test mark correlation coefficient between the first and subsequent correctors. The correlation coefficients are shown in the following table:

Table 2. Correlation between marks awarded by correctors

Experimental Class		Control	In all
Digital Mind Mapping	Collaborative Learning		
0.997	0.986	0.996	0.992

The table displays the correlation coefficients above demonstrating that the two test correctors provide consistent marks. This proves that the analytical scores were accurate.

Equivalence of the experimental class and control class

Comparing the pre-test and post-test results for the experimental class and the experimental and control groups' post-test results helped determine the experimental class's cognitive learning rate, which provided a more precise and providing a more accurate depiction of the impact of Digital Mind Mapping. The Mann-Whitney Test was used to compare the pre-test outcomes between the experimental and control groups' courses on Ocean and Jungle Animals.

Table 3. Comparability of pre-test scores between the experimental and control classes

Topic	Group	N	Mean Rank	Sum of Ranks	Mean-Whitney U	Z
Ocean Animals	Control	30	10.75	129.00	51.00	1.472
	Experimental	32	15.08	196.00		
	Control	30	10.64	117.00	51.00	0.629

Jungle Animals	Experimental	32	12.36	136.00		

The table above illustrates :

o There is no statistically significant difference in the average rankings on the Ocean Animals pre-test between the experimental and control classes.

o There is no statistically significant difference in the average rankings on the Jungle Animals pre-test between the experimental and control courses.

Results

Comparing the experimental and control classes on the post-test application.

The Mann-Whitney Test was employed in post-test analysis to evaluate significant differences in experimental and control group average rankings.

Table 4. Importance of post-test differences between experimental and control groups

Topic	Group	N	Mean Rank	Sum of Ranks	Mean-Whitney U	Z
Ocean Animals	Control	30	7.73	85.00	19.00	3.066**
	Experimental	32	16.54	215.00		
Jungle Animals	Control	30	7.41	81.50	15.50	3.120**
	Experimental	32	16.21	194.50		

Based on the above table, we determine :

o A significant difference ($p \leq 0.01$) in mean Reading Comprehension Material test 1 (Ocean Animals) scores favoured the experimental group.

o A substantial difference ($p \leq 0.01$) was seen in the mean ranks of experimental and control classes in the first school after passing the Reading Comprehension Material test 2 (Jungle Animals).

A comparison was conducted between the post-application scores, regarding the Reading Comprehension exam, it was administered to both the experimental class and the control class

One-way ANOVA revealed significant differences in the experimental class's post-application reading comprehension assessment.

Table 5. Descriptive statistics were conducted on the post-test outcomes of the experimental class

Class	N	Mean	Std. Deviation	Minimum	Maximum
1	32	7.4541	1.91653	5.00	10.00
2	30	5.1224	2.06674	1.00	9.60
Total	62	5.8700	2.18733	1.00	10.00

Table 6. ANOVA test results for the post-test scores of the experimental class

	Sum of Squares	df	Mean Square	F	Sig.
Between Class	91.538	2	45.769	12.553	.000
Within Class	262.507	72	3.646		
Total	354.045	74			

** $p \leq 0.01$

According to Table (6), the experimental class in the three schools showed Significant gaps ($p \leq 0.01$) after using the Reading Comprehension test. To find differences, use the Scheffe test for multiple comparisons.

Table 7. Scheffe Test Results

Mean Difference		
Class	1 (M= 8.115)	2 (M= 5.034)
Experimental (M= 5.034)	3.08160**	
Control (M= 5.940)	2.17538**	0.90622

** p≤ 0.01

According to the table, the experimental group achieved the maximum possible post-test average, as compared to the other control group, there were notable disparities (p≤ 0.01).

Pre- and post-test results for the experimental and other classes were compared.

To identify statistically significant shifts, the Wilcoxon test was used. The experimental group's mean pre- and post-test scores.

Table 8. The outcome of the Wilcoxon Signed Ranks Test

Test	Ranks	N	Mean Rank	Sum of Ranks	Z	Effect Size
Post Test	Negative Ranks	1	1.50	1.50	3.077**	3.170
	Positive Ranks	12	7.46	89.50		
	Ties	0				
Pre Test	Negative Ranks	2	2.00	4.00	2.582**	2.387
	Positive Ranks	9	6.89	62.00		
	Ties	0				

** p≤ 0.01

The table shows significant differences (p≤ 0.01) in mean ranks for experimental group students after applying the Reading Material with Digital Mind Mapping exam, compared to the pre-application test, shown a substantial improvement with a substantial effect size. The same goes for Reading Comprehension exam results.

Control class pre- and post-test results were compared

To determine if there were statistically significant changes in the control group's mean scores between the pre- and post-test periods, the Wilcoxon test was used.

Table 9. The outcome of the Wilcoxon Signed Ranks Test

Test	Ranks	N	Mean Rank	Sum of Ranks	Z
Post Test	Negative Ranks	5	6.30	31.50	0.133
	Positive Ranks	6	5.75	34.50	
	Ties	0			
Pre Test	Negative Ranks	6	5.08	30.50	0.967
	Positive Ranks	3	4.83	14.50	
	Ties	2			

The data from the preceding table indicates that the average rankings of control group students before and after the Reading Material exam were not statistically significant. The same is true for the results of the Reading Material tests.

Paired Samples T-Test was used to determine whether the control group's average scores were significantly different before and after the Reading test. Table 10 shows the results:

Table 10. Paired samples T-test results

Test	Mean	Std. Deviation	Differences		T
			Mean	Std. Deviation	
Pre-	3.608	1.528	0.414	1.250	2.030
Post	4.022	1.787			

The table above shows no statistically significant change in control group average scores before and after Reading Test 1. According to the table above, the control group's average score did not change significantly before and after Reading test 2. One-way ANOVAs used pretest results as covariates to find significant differences in experimental class post-test results. The findings are shown in tables (11) and (12):

Table 11 Experimental class post-test descriptive statistics

Class	N	Mean	Std. Deviation	Minimum	Maximum
Experimental Class	36	5.063	2.088	1.00	9.50

Table 12. The experimental class post-test results were examined using the ANOVA test, using pre-test results as the covariate

Source	Sum of Squares	df	Mean Squares	F	Sig.
Covariate	1.564	1	1.564	0.394	0.532
Scholes	25.901	2	12.950	3.261	0.045
Error	266.078	67	3971		
Corrected Total	292.984	70			

** $p \leq 0.01$

As seen in the tables, the experimental class's post-reading test modifications were statistically significant (p=0.045). The differences were identified using a Scheffe test for Multiple Comparisons.

Table 13. Scheffe Test Results

Mean Difference (derived from calculated marginal means)		
Class	1	2
Experimental	1.506*	
Control	0.527	0.979

This table shows that the experimental group had the highest mean test score following implementation. In addition, the differences across the classes were determined to be statistically significant, with a p-value of 0.05.

An analysis of qualitative and quantitative findings

This section compares qualitative and quantitative results. This study employed quantitative methods pre- and post-test. However, qualitative tools were employed during observation and interviews, which is significant. This is also substantially connected with sub-theme-related qualitative data results. By investigating real-world causes, the qualitative technique offers a more complete picture of the results. During interviews, teachers and students stated that Collaborative Learning using Digital Mind Mapping promotes student success, helping the educational process. The researcher also tracked course participation and communication to determine instructors' and students' opinions on this strategy.

The quantitative approach supports this with actual evidence, inquiry, interpretation, confirmation, and prediction. Kids and instructors found this strategy effective, as kids comprehended and learned more. Students remembered the course information longer by improving and scoring better on the post-test, and their performance was superior to the pre-test. The contrast in Table 14 is summarised below :

Table 14. An analysis of the differences Mixed Method findings

	Themes & sub-themes	Class			
		Control Class (C)		Experimental Class (X)	
		The outcome of the Quantitative Methodologies	The outcome of Qualitative Methodologies	The outcome of the Quantitative Methodologies	The outcome of Qualitative Methodologies
	Ensuring the continued effectiveness of ICT in enhancing learning outcomes, comprehension, efficiency, and overall learning experience	The post-test had a mean score that was below X.	Students also noted the challenge of differentiating between several classes due to their overlapping content .	The mean score in the post-test exceeded that of the pre-test	It enables students to enhance their long-term memory, as shown by the class-administered test.

The table above shows that qualitative and quantitative findings for enhanced academic accomplishment in themes and sub-themes are similar. The use of Digital Mind Mapping with Collaborative Learning had a significant impact on the classrooms.

The experimental group, which used Digital Mind Mapping in combination with Collaborative Learning, showed significantly better results than the control group, which relied on traditional learning methods. However, the study could benefit from a more comprehensive interpretation of these results, as well as an exploration of the underlying factors that may have contributed to these outcomes. One key observation in the results was that students in the experimental group demonstrated higher engagement and participation, especially during collaborative activities. This finding is significant, as it suggests that Digital Mind Mapping, combined with peer interaction, can foster a more dynamic and interactive learning environment, which is conducive to higher engagement levels. This increase in engagement likely contributed to the enhanced performance in reading comprehension observed in the experimental group. However, the study does not delve deeply into why this engagement occurred or how it affected cognitive processing. Future research could explore how Digital Mind Mapping, by visualizing complex ideas and relationships between concepts, might facilitate deeper cognitive engagement and help students organize information more effectively, thereby improving comprehension.

The improvement in test scores for the experimental group is another important finding, but the study only briefly mentions this without offering a thorough explanation of the mechanisms behind this improvement. One possible explanation, rooted in cognitive psychology, is that Digital Mind Mapping helps students externalize their thought processes and create visual representations of knowledge, which aids in better retention and retrieval of information. Additionally, the collaborative aspect of learning could have encouraged students to articulate their ideas more clearly, engage in critical thinking, and learn from their peers' perspectives, all of which are known to enhance comprehension and learning outcomes. However, the study does not thoroughly explore these potential cognitive benefits, and this limits our understanding of how and why Digital Mind

Mapping and Collaborative Learning were so effective.

Moreover, the study highlights that students in the control group, who followed traditional learning methods, struggled to maintain engagement and often lost focus during lessons. This is an important point, as it underscores the limitations of traditional, teacher-centered approaches, particularly in fostering active learning and critical thinking. However, the discussion could have been more expansive in explaining why traditional methods were less effective in this context. For instance, traditional methods often involve passive learning, where students receive information without actively processing it, which can lead to disengagement and poor retention. In contrast, Digital Mind Mapping encourages students to take a more active role in their learning, requiring them to make connections between ideas and think critically about the material. The researchers could have provided a more detailed explanation of how these differences in learning approaches contributed to the observed outcomes.

Additionally, the study briefly touches upon the statistical significance of the test results, particularly the improvement in reading comprehension in the experimental group, but does not provide enough detail regarding the magnitude of this improvement or its practical implications. A more detailed discussion of the statistical findings could have shed light on the strength of the effect and its potential applicability in broader educational contexts. For example, did certain types of reading materials benefit more from Digital Mind Mapping than others? Was there a particular type of student (e.g., those with stronger digital literacy skills) who gained more from the intervention? Exploring these questions would help educators understand how Digital Mind Mapping and Collaborative Learning can be tailored to maximize their effectiveness in different learning scenarios.

Furthermore, while the study notes that Digital Mind Mapping and Collaborative Learning contributed to a more engaging and interactive learning environment, it does not sufficiently explore the potential challenges or limitations of these methods. For instance, implementing Digital Mind Mapping and Collaborative Learning in the classroom likely requires a certain level of digital literacy among both students and teachers. If students are not comfortable with the technology, or if teachers do not have adequate training in using these tools effectively, the potential benefits of Digital Mind Mapping and Collaborative Learning could be diminished. The study could have discussed these potential barriers in more detail and provided recommendations for overcoming them, such as offering training for teachers or ensuring that students have access to the necessary technology.

Furthermore, the findings indicate a correlation Between the numerical data and some aspects of the qualitative approach. This is apparent from the interviews and observations and is reflected in the topics indicated in the table above. While the experimental class recognised the significance of Digital Mind Mapping with Collaborative Learning, their interpretations and specificities varied. In the control class, it is apparent that students achieved a lower score compared to the experimental class. The rationales for this varied depending on each ability to comprehend the materials. Firstly, although the experimental class achieved the best scores across all tests, the control group said they had difficulty distinguishing some courses since they seemed to address similar subject matter. This discrepancy may be attributed to the restricted ways of learning used, which seemed to rely heavily on the textbook and the teacher's lectures. Finally, interviews and observations indicated that the students in the control class forgot the main themes since they were just passive activities. In contrast, The results from the experimental group using the Collaborative Learning with Digital Mind Mapping technique showed that it improved students' ability to remember information and boosted their academic achievements.

In summary, while the results of the study indicate that Digital Mind Mapping and Collaborative Learning significantly improved student engagement and reading comprehension, the analysis and discussion could be more comprehensive. A deeper exploration of the cognitive mechanisms behind these improvements, a more detailed analysis of the statistical results, and a discussion of the practical challenges of implementing these methods would have provided a more robust and insightful interpretation of the findings. By expanding on these areas, future research could offer more detailed guidance on how to effectively integrate Digital Mind Mapping and Collaborative Learning into educational settings to maximize their potential benefits for students.

Discussion

Through a mixed-methods approach, the researchers found that students in the experimental group, who utilized Digital Mind Mapping and Collaborative Learning, showed significantly higher engagement and participation levels compared to their peers in the control group, who followed traditional teaching methods. Quantitative results indicated that the experimental group achieved better academic outcomes, with notably higher scores on reading comprehension tests across various topics. The collaborative nature of Collaborative Learning was crucial in fostering peer-to-peer interaction, allowing students to work together, exchange ideas, and gain a deeper understanding of the material. This dynamic contributed to improved critical thinking and academic performance. Qualitative interviews further reinforced these findings, with both teachers and students reporting enhanced long-term memory retention and a more engaging learning experience. The findings from this study align with previous research, such as Bhattacharya & Mohalik (2020), who highlighted how digital mind mapping fosters creativity and critical thinking, and (Vejayan & Md. Yunus, 2022), who observed improvements in students' narrative writing through the use of Digital Mind Mapping. Additionally, (Winata & Rahmat, 2022) found that digital mind mapping significantly enhanced reading comprehension in EFL settings, which closely mirrors the outcomes observed by Sagita et al. The integration of Digital Mind Mapping and Collaborative Learning not only motivated students but also helped in structuring knowledge more effectively, leading to superior academic achievements. Overall, the study provides robust evidence that combining Digital Mind Mapping with Collaborative Learning offers a promising approach to enhancing student engagement, fostering deeper learning, and improving academic performance, especially in reading comprehension tasks. These conclusions are consistent with a growing body of literature supporting the use of technology-driven collaborative methodologies in modern education, further demonstrating the benefits of incorporating such tools to create a more interactive and productive learning environment

Conclusion and Implications

Implementing ICT and digital technologies with current teaching methodologies, such as Digital Mind Mapping with Collaborative Learning, may boost their significant interest in education. It facilitates student-centred learning, promoting interactive and engaged learning in new educational research. When digital and collaborative learning are combined, students concentrate more on the educational process and have better conversations. The ‘force multiplier’ concept highlights the connection between teaching roles, collaborative learning, and digital technology in facilitating student learning.

Research supports Digital Mind Mapping as an approach, but more is needed. The current study supports the study's aim to investigate the research goals and show how digital mind mapping with collaborative learning improves student academic achievement in reading comprehension subjects, compared to traditional methods.

For theoretical implications, consider the usefulness of the literature's hypotheses. The findings supported group technology usage discourse and collaboration. The Digital Mind Map discussion and conversation in collaborative groups facilitated the sharing of experiences, promoted analytical thinking, and stimulated engagement. These findings were achieved using mixed methods. During interviews with instructors and students, they told me that this classroom technique involves interaction, discourse, discussion, and collaboration. The researcher validated this via class observation. Additionally, the quantitative and qualitative techniques supported the conclusions above. This strategy supports the instructor in class like a teaching assistant. Students and instructors believed the digital mind map increases higher-order thinking abilities including writing, analysis, summarization, technology and communication skills, cooperation, and acceptance of diverse ideas. This reinforces lesson understanding and helps students develop 21st-century abilities.

However, technological issues and a lack of training for students and teachers hinder technology's potential to improve academic performance. Finally, these findings suggest Digital Mind Mapping as a teaching approach, although additional study is needed. As stated in the introduction's issue statement, this study supports future research on this subject.

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Conflict of Interest

I declared there is no conflict of interest..

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