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## Developing Students' English Reading Skills through the Use of Cluster Technology: A Methodological Approach

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**Annotation** *Reading comprehension is a key skill in English as a Foreign Language (EFL) learning, yet many learners struggle to process complex texts due to limited vocabulary, weak reading strategies, and difficulties in organizing information. Visual learning approaches such as cluster technology, including mind maps, concept maps, and graphic organizers, have been suggested as effective tools for improving comprehension. This study investigates the effectiveness of cluster-based strategies in developing students' English reading skills. A quasi-experimental design with pre-test and post-test control groups was implemented among undergraduate EFL learners. During the intervention, the experimental group used cluster mapping techniques to analyze reading texts, while the control group received traditional reading instruction. The results revealed that students who used cluster technology demonstrated significantly higher reading comprehension scores and improved ability to identify relationships among textual ideas. The findings suggest that cluster technology enhances cognitive processing of textual information and provides an effective instructional strategy for improving reading comprehension in EFL classrooms.*

**Keywords** *Reading comprehension, cluster technology, mind mapping, graphic organizers, EFL learning*

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## Klaster texnologiyasidan foydalanish asosida talabalarning ingliz tilidagi o'qish ko'nikmalarini rivojlantirishning metodik yondashuvi

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**Annotatsiya** *O'qib tushunish ingliz tilini chet tili sifatida o'rganishda (English as a Foreign Language – EFL) muhim ko'nikmalardan biri hisoblanadi. Biroq ko'plab o'quvchilar murakkab matnlarni tushunishda qiyinchiliklarga duch keladilar. Bunga lug'at boyligining yetarli emasligi, o'qish strategiyalarining sustligi hamda ma'lumotlarni tizimli tarzda tashkil eta olmaslik kabi omillar sabab bo'ladi. Vizual o'rganishga asoslangan yondashuvlar, xususan klaster texnologiyasi (mind map, konsept xaritalari va grafik organizatorlar) o'qib tushunishni rivojlantirishda samarali vosita sifatida tavsiya etilmoqda. Mazkur tadqiqot talabalarning ingliz tilidagi o'qish ko'nikmalarini rivojlantirishda klasterga asoslangan strategiyalarning samaradorligini o'rganishga qaratilgan. Tadqiqotda oldindan test va yakuniy testga ega bo'lgan kvazi-eksperimental dizayn qo'llanilib, unda ingliz tilini chet tili sifatida o'rganuvchi bakalavr talabalari ishtirok etdi. Tajriba jarayonida eksperimental guruh o'qish matnlarini tahlil qilishda klaster xaritalash texnikalaridan foydalandi, nazorat*

*guruhi esa an'anaviy o'qish metodlari asosida ta'lim oldi. Natijalar shuni ko'rsatdiki, klaster texnologiyasidan foydalangan talabalar o'qib tushunish bo'yicha sezilarli darajada yuqori natijalarni ko'rsatdi hamda matndagi g'oyalar o'rtasidagi bog'lanishlarni aniqlash qobiliyati yaxshilandi. Tadqiqot natijalari klaster texnologiyasi matnli ma'lumotlarni kognitiv qayta ishlashni kuchaytirishini va ingliz tilini chet tili sifatida o'qitiladigan sinflarda o'qib tushunishni rivojlantirish uchun samarali o'qitish strategiyasi ekanligini ko'rsatadi.*

**Kalit so'zlar** *O'qib tushunish, klaster texnologiyasi, mind map, grafik organizatorlar, ingliz tilini chet tili sifatida o'rganish*

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## **Методический подход к развитию навыков чтения на английском языке у студентов на основе использования кластерной технологии**

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**Аннотация** *Чтение с пониманием является важным навыком при изучении английского языка как иностранного (EFL). Однако многие учащиеся испытывают трудности при работе со сложными текстами из-за ограниченного словарного запаса, слабых стратегий чтения и трудностей в организации информации. Визуальные методы обучения, такие как кластерная технология, включая интеллект-карты (mind maps), концептуальные карты и графические организаторы, рассматриваются как эффективные средства для улучшения понимания текста. Данное исследование направлено на изучение эффективности кластерных стратегий в развитии навыков чтения на английском языке у студентов. В исследовании использовался квазиэкспериментальный дизайн с предварительным и итоговым тестированием контрольной и экспериментальной групп. В исследовании приняли участие студенты бакалавриата, изучающие английский язык как иностранный. В ходе эксперимента студенты экспериментальной группы использовали кластерные карты для анализа текстов для чтения, тогда как контрольная группа обучалась с использованием традиционных методов чтения. Результаты показали, что студенты, применявшие кластерную технологию, продемонстрировали значительно более высокие показатели понимания прочитанного и улучшили способность выявлять взаимосвязи между идеями текста. Полученные результаты свидетельствуют о том, что кластерная технология способствует более эффективной когнитивной обработке текстовой информации и является эффективной стратегией обучения для развития навыков чтения в классах, где английский язык преподаётся как иностранный.*

**Ключевые слова** *Понимание прочитанного, кластерная технология, интеллект-карты, графические организаторы, изучение английского языка как иностранного*

## Introduction

Reading is one of the most essential skills in second language learning because it enables learners to access knowledge, interpret information, and participate in academic communication. In English as a Foreign Language (EFL) contexts, reading comprehension plays a particularly important role in academic development. However, many learners experience difficulties when processing academic texts because they must simultaneously interpret unfamiliar vocabulary, grammatical structures, and complex conceptual relationships. Reading in a foreign language therefore requires the integration of linguistic knowledge, background knowledge, and strategic processing skills (Bernhardt, 1986; Grabe & Stoller, 2002).

Previous research indicates that EFL learners often struggle to construct coherent meaning from texts due to limited vocabulary knowledge and insufficient reading strategies. While many learners are able to recognize individual words, they frequently encounter difficulties when interpreting larger textual structures and identifying logical relationships between ideas (Grabe & Stoller, 2002). Studies on second language reading further suggest that effective comprehension requires learners to integrate information across sentences and recognize discourse-level connections such as cause-effect relationships, comparison structures, and supporting arguments (Bernhardt & Kamil, 1995). Understanding these textual relationships is essential for interpreting academic texts and constructing meaningful representations of information.

Traditional reading instruction in many language classrooms continues to rely on teacher-centered practices such as translation, vocabulary explanation, and sentence-level interpretation. Although these techniques may help learners understand isolated parts of a text, they often fail to develop higher-order reading strategies required for interpreting

complex discourse structures. As a result, students may remain passive readers who depend heavily on teachers rather than actively constructing meaning from texts. Scholars in language pedagogy therefore emphasize the importance of learner-centered instructional approaches that promote strategic and cognitive engagement during reading activities (Brown, 2001).

Recent developments in language pedagogy highlight the potential of visual learning strategies that support the cognitive processing of textual information. One such approach is cluster technology, which involves the use of visual tools such as mind maps, concept maps, and graphic organizers to represent relationships between ideas within a text. These visual representations transform linear textual information into structured conceptual networks that are easier for learners to interpret and remember (Novak, 2010).

Research demonstrates that graphic organizers and concept mapping strategies can significantly improve reading comprehension by helping learners organize information and identify relationships between textual concepts (Ayiz & Hidayatulloh, 2024). Experimental studies also indicate that visual mapping strategies enhance learners' ability to analyze textual structures and integrate new information with existing knowledge frameworks (Heidarifard, 2014). Similarly, recent meta-analytic evidence suggests that concept mapping strategies have a positive effect on second language learning outcomes, particularly in improving comprehension and cognitive engagement with texts (Han, 2025).

Despite these promising findings, several gaps remain in the existing literature. First, many studies focus primarily on the use of technological tools rather than examining how cluster technology can be systematically integrated into reading instruction. Second, previous research frequently investigates isolated classroom activities rather than

proposing comprehensive methodological frameworks for implementing cluster-based strategies in language classrooms. Third, there remains limited research exploring the cognitive mechanisms through which cluster technology facilitates reading comprehension among EFL learners.

To address these gaps, the present study investigates the methodological role of cluster technology in developing students' English reading skills. The study proposes a structured instructional approach that integrates cluster-based strategies into reading instruction in order to promote deeper comprehension and cognitive engagement.

The contribution of this research lies in its integration of theoretical perspectives from schema theory, sociocultural theory, and dual coding theory to explain how cluster-based strategies enhance reading comprehension. By combining theoretical insights with classroom-based experimentation, this study also provides practical pedagogical implications for language teachers seeking to incorporate visual learning strategies into EFL reading instruction.

### **Literature Review**

#### *Reading Comprehension in EFL Learning*

Reading comprehension is an interactive cognitive process in which readers construct meaning by integrating textual information with their prior knowledge and linguistic competence. In foreign language contexts, reading requires learners to coordinate vocabulary knowledge, grammatical understanding, and strategic processing skills in order to interpret meaning from written texts (Bernhardt, 1986). Scholars have also emphasized that second language reading involves the interaction between first-language literacy skills and target-language knowledge, suggesting that learners often transfer reading strategies from their native language when processing texts in a foreign language (Bernhardt & Kamil, 1995).

EFL learners frequently encounter difficulties when reading complex academic texts because they must simultaneously

decode unfamiliar vocabulary and interpret conceptual relationships within discourse. According to Grabe and Stoller (2002), effective reading instruction should therefore focus not only on vocabulary development but also on the use of strategic reading techniques that help learners organize and interpret textual information. Research on language pedagogy further highlights that successful reading comprehension requires the ability to recognize discourse cohesion and structural relationships among ideas within a text (Halliday & Hasan, 1976). When learners fail to identify such relationships, comprehension becomes fragmented and superficial.

#### *Concept Mapping and Mind Mapping in Language Learning*

Concept mapping is a cognitive learning strategy that visually represents relationships between concepts in a hierarchical structure. Originally introduced as a tool for facilitating meaningful learning, concept mapping enables learners to organize knowledge, identify relationships among ideas, and integrate new information with existing cognitive structures. Novak (2010) explains that concept maps promote deeper learning because they encourage learners to actively construct connections between concepts rather than simply memorizing isolated pieces of information.

Empirical studies have shown that knowledge mapping techniques can significantly enhance comprehension and knowledge organization in educational settings. For example, Bahr and Dansereau (2005) found that knowledge mapping strategies improved students' ability to understand and recall textual information by making conceptual relationships more explicit. Similarly, research in second language contexts suggests that concept mapping enhances learners' awareness of reading strategies and improves comprehension of complex texts (Rassaei, 2019).

Meta-analytic studies further confirm the effectiveness of concept mapping as an

instructional strategy. Nesbit and Adesope (2006) analyzed numerous experimental studies and concluded that concept mapping has a significant positive impact on learning outcomes across various educational contexts. More recent meta-analytic research has also demonstrated that concept mapping strategies contribute to improved reading comprehension and vocabulary development among second language learners (Han, 2025).

#### *Graphic Organizers and Reading Instruction*

Graphic organizers are visual tools designed to help learners represent relationships between ideas within a text. By transforming linear textual information into structured visual formats, graphic organizers make it easier for learners to identify key concepts, supporting details, and logical relationships within discourse.

Research indicates that the use of graphic organizers significantly improves students' reading comprehension performance. For instance, Heidarifard (2014) found that graphic organizers enhanced L2 learners' ability to interpret and summarize textual information. Similarly, recent experimental studies show that graphic organizers can improve meaningful reading by helping learners structure information and recognize relationships between textual elements (Ayiz & Hidayatulloh, 2024). Other studies also demonstrate that mind mapping strategies improve learners' ability to analyze textual structures and support deeper comprehension during reading tasks (Chalak & Rastgoo, 2021).

In addition to improving comprehension, graphic organizers also promote active engagement with reading materials. When learners construct visual representations of textual information, they must analyze relationships among ideas and reorganize information in meaningful ways. This process encourages deeper cognitive processing and enhances the retention of information.

#### *Technology-Enhanced Cluster Strategies*

Recent advances in educational technology have expanded the application of visual mapping strategies in language learning environments. Digital concept mapping tools allow learners to construct and modify conceptual diagrams more efficiently while also supporting collaborative learning activities.

Studies suggest that computer-assisted concept mapping systems can significantly improve reading comprehension and knowledge organization among language learners. For example, Liu, Chen, and Chang (2010) demonstrated that computer-assisted concept mapping improved EFL students' reading comprehension by helping them visualize relationships among textual concepts. Similarly, Liu (2011) reported that computerized mapping environments encourage active learner participation and facilitate deeper engagement with learning materials.

Digital mind mapping tools also support collaborative learning and knowledge construction in educational settings. Mancao and Dequito (2022) found that digital mapping platforms enhance collaborative learning by allowing students to share and refine conceptual representations of knowledge. In addition, mobile mind mapping applications have been shown to improve vocabulary acquisition and language learning outcomes among EFL learners (Shi & Tsai, 2024). Research also suggests that mind mapping strategies promote higher-order thinking skills by encouraging learners to analyze, synthesize, and organize information more effectively (Wang, 2020).

#### *Conceptual Framework*

The conceptual framework of this study is based on the assumption that cluster technology facilitates reading comprehension by supporting the visual organization of textual information and reducing cognitive load during reading tasks. Visual mapping strategies enable learners to structure textual information in ways that make conceptual relationships more explicit and easier to interpret.

The framework integrates three theoretical perspectives:

- *Schema Theory*

Schema theory suggests that comprehension improves when learners connect new information with their existing knowledge structures. When students activate prior knowledge during reading, they are better able to interpret new textual information and construct meaningful representations of content.

- *Dual Coding Theory*

Dual coding theory proposes that information presented through both verbal and visual channels enhances memory and comprehension. Visual representations such as concept maps and graphic organizers therefore

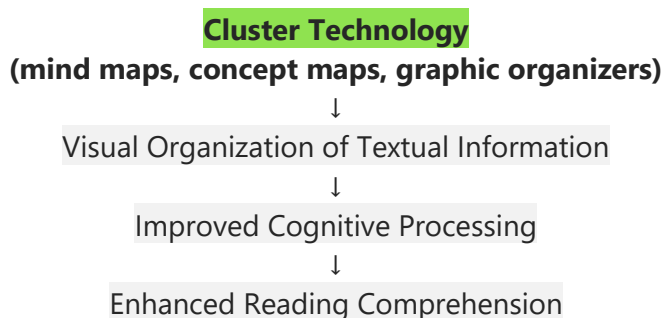
support learning by providing additional cognitive pathways for processing information.

- *Sociocultural Theory*

Sociocultural theory emphasizes the role of tools and social interaction in the learning process. From this perspective, visual mapping strategies function as cognitive tools that mediate learning by enabling students to organize knowledge collaboratively and construct meaning through interaction.

Based on these theoretical perspectives, cluster technology can be understood as a cognitive support mechanism that helps learners visualize relationships among textual ideas and actively construct meaning during reading activities.

## CONCEPTUAL MODEL



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## Methodology

### Research Design

This study employed a quasi-experimental mixed-methods research design to investigate the effectiveness of cluster technology in improving students' English reading comprehension. A quasi-experimental design was considered appropriate because it allows researchers to examine cause-effect relationships in authentic classroom environments where random assignment of participants is not always feasible (Creswell, 2018). Such designs are commonly used in applied linguistics and educational research when investigating instructional interventions in real classroom contexts.

The study followed a pre-test–post-test control group design, which enabled comparison of learning outcomes between students who received cluster-based reading instruction and those who were taught using traditional reading methods. Quantitative data were collected through reading comprehension tests administered before and after the intervention to measure improvements in students' reading performance. Qualitative data were collected through a structured questionnaire that explored students' perceptions of cluster-based learning strategies.

The integration of quantitative and qualitative data allowed the study to examine

both the effectiveness of the instructional intervention and learners' experiences when using visual learning strategies in reading activities. Previous research has shown that visual mapping strategies can significantly improve comprehension and cognitive engagement in language learning contexts (Nesbit & Adesope, 2006; Han, 2025).

#### *Participants*

The participants consisted of 60 undergraduate students enrolled in a compulsory English reading course at a university. All participants were studying English as a Foreign Language and had completed at least one year of university-level English instruction.

Participants were divided into two groups:

- Experimental group (n = 30)
- Control group (n = 30)

The participants were selected using purposive sampling in order to ensure relatively similar English proficiency levels between the two groups. Prior to the intervention, both groups completed a reading comprehension pre-test to determine their baseline reading proficiency and confirm that there were no statistically significant differences between the groups at the beginning of the study.

The participants were between 18 and 21 years old and had comparable educational backgrounds and exposure to English language instruction. Similar participant selection procedures have been used in previous studies examining the effects of visual mapping strategies on reading comprehension in EFL contexts (Ayiz & Hidayatulloh, 2024; Chalak & Rastgoo, 2021).

#### *Instruments*

Three primary instruments were used to collect data in this study: a reading comprehension test, cluster mapping tasks, and a student perception questionnaire.

#### *Reading Comprehension Test*

A standardized reading comprehension test was used as both a pre-test and a post-test to measure students' reading performance. The

test consisted of several academic reading passages followed by multiple-choice and short-answer questions designed to assess students' ability to:

- identify main ideas
- interpret supporting details
- recognize relationships between concepts
- make inferential interpretations of texts

Reading comprehension tests are widely used in second language research to measure learners' ability to process textual information and interpret relationships among ideas (Grabe & Stoller, 2002). The reliability of the test was verified through pilot testing with students of similar proficiency levels. Internal consistency was calculated using Cronbach's alpha coefficient, which indicated acceptable reliability.

#### *Cluster Mapping Tasks*

Students in the experimental group completed cluster mapping activities during reading instruction. These activities required students to construct visual representations of textual information using mind maps and concept maps. Learners were instructed to identify key concepts in reading passages and visually represent relationships between ideas through cluster diagrams.

Concept mapping has been widely recognized as an effective strategy for organizing knowledge and facilitating meaningful learning (Novak, 2010). Research also indicates that visual mapping strategies improve learners' ability to understand complex texts by making conceptual relationships more explicit (Bahr & Dansereau, 2005; Rassaei, 2019).

#### *Student Perception Questionnaire*

A Likert-scale questionnaire was administered to students in the experimental group at the end of the instructional intervention. The purpose of the questionnaire was to evaluate students' perceptions of cluster-based reading strategies and their usefulness for improving reading comprehension.

The questionnaire included items related to:

- ease of use of cluster mapping strategies
- perceived improvement in reading comprehension
- motivation and engagement during reading tasks

Students responded to each item using a five-point Likert scale ranging from strongly disagree to strongly agree. Questionnaires are commonly used in language education research to examine learners' attitudes toward instructional strategies and learning experiences.

#### *Procedure*

The experimental intervention was conducted over a six-week period during regular classroom sessions.

#### *Week 1: Pre-test*

At the beginning of the study, both the experimental and control groups completed the reading comprehension pre-test. The purpose of this test was to determine students' initial reading proficiency and confirm that the two groups had comparable baseline abilities.

#### *Weeks 2-5: Instructional Treatment*

During the four-week intervention period, the two groups received different instructional approaches.

Students in the experimental group were taught using cluster-based reading strategies, including mind mapping and concept mapping techniques. During reading activities, students analyzed reading passages by identifying key ideas and visually organizing relationships among concepts using cluster diagrams. Previous research has shown that visual mapping strategies can significantly improve comprehension by helping learners organize and interpret textual information more effectively (Heidarifard, 2014; Liu, Chen, & Chang, 2010).

In contrast, the control group received traditional reading instruction. Classroom activities in this group primarily involved vocabulary explanation, translation of

sentences, and teacher-led discussion of reading passages. Students in this group did not use visual clustering strategies during reading tasks.

#### *Week 6: Post-test and Questionnaire*

At the conclusion of the intervention, both groups completed the reading comprehension post-test in order to measure changes in reading comprehension performance following the instructional treatment.

Students in the experimental group also completed the perception questionnaire, which provided qualitative insights into their experiences using cluster-based reading strategies and their perceived usefulness for improving reading comprehension.

#### *Data Analysis*

Quantitative data obtained from the pre-test and post-test were analyzed using descriptive and inferential statistical methods. Mean scores and standard deviations were calculated to examine changes in students' reading comprehension performance.

To determine whether the instructional intervention produced statistically significant improvements in reading comprehension, an independent-samples t-test was used to compare the post-test scores of the experimental and control groups. In addition, a paired-samples t-test was conducted to examine within-group differences between pre-test and post-test scores.

These statistical procedures are commonly applied in educational research to evaluate the effectiveness of instructional interventions and to determine whether observed differences between groups are statistically significant.

Qualitative data from the student perception questionnaire were analyzed descriptively by examining patterns in students' responses to Likert-scale items. The results were used to provide additional insights into students' experiences with cluster-based learning strategies.

## Results

The results of the study indicate that the use of cluster technology had a positive effect on students' reading comprehension performance.

Analysis of the pre-test scores showed no statistically significant difference between the experimental group and the control group at the beginning of the study. The mean pre-test score for the experimental group was approximately 55, while the control group demonstrated a comparable level of reading proficiency. This result suggests that the two groups were relatively equivalent before the instructional intervention.

Following the four-week instructional treatment, the post-test results revealed a noticeable difference between the two groups. The mean score of the experimental group increased from approximately 55 in the pre-test to around 80 in the post-test. In contrast, the control group demonstrated only moderate improvement over the same period.

An independent-samples t-test was conducted to compare the post-test scores of the two groups. The analysis indicated that the experimental group achieved significantly higher scores than the control group, suggesting that the use of cluster-based reading strategies had a positive effect on students' reading comprehension performance.

Further analysis of students' responses indicated that learners in the experimental group demonstrated improvement in several key aspects of reading comprehension, including:

- identifying the main ideas of texts
- recognizing relationships between concepts and supporting details
- organizing textual information logically
- retaining important information from reading passages

These results suggest that cluster technology helped students structure textual information more effectively during the reading process.

## Questionnaire Results

The responses from the student perception questionnaire also provided additional insights into students' experiences with cluster-based learning strategies. Most participants in the experimental group reported positive attitudes toward the use of visual mapping techniques during reading activities.

A large proportion of students indicated that mind maps and concept maps helped them understand complex texts more easily and improved their ability to identify relationships among ideas. Many students also reported that cluster-based activities increased their motivation and engagement during reading tasks.

Overall, the questionnaire results suggest that students perceived cluster technology as a useful and effective tool for supporting reading comprehension and organizing textual information.

## Discussion

The findings of this study indicate that the use of cluster technology significantly improves students' reading comprehension by facilitating the cognitive organization of textual information. Students who engaged in cluster-based reading activities demonstrated stronger abilities to identify relationships among ideas, organize textual information logically, and retain key concepts from reading passages. These results suggest that visual clustering strategies provide learners with structured tools that support deeper engagement with texts.

From a theoretical perspective, the findings support schema theory, which proposes that comprehension improves when learners connect new information with their existing knowledge structures. When students construct mind maps or concept maps during reading, they activate prior knowledge and integrate new textual information into organized conceptual frameworks. This process helps learners interpret relationships among ideas and construct coherent representations

of textual meaning. Previous research has also highlighted the importance of activating background knowledge in facilitating reading comprehension among second language learners (Bernhardt, 1986; Grabe & Stoller, 2002).

The results of the study are also consistent with dual coding theory, which suggests that learning becomes more effective when information is processed through both verbal and visual channels. Visual representations such as mind maps and graphic organizers allow learners to process textual information not only through linguistic structures but also through visual relationships among concepts. This dual representation strengthens memory and comprehension by providing multiple cognitive pathways for information processing. Empirical studies have similarly demonstrated that visual mapping strategies can enhance comprehension by helping learners organize and interpret textual information more effectively (Nesbit & Adesope, 2006; Han, 2025).

In addition, the findings align with previous research on concept mapping and graphic organizers in language learning. Studies have shown that concept mapping strategies support learners in identifying relationships between ideas and constructing meaningful knowledge structures during reading activities (Novak, 2010; Rassaei, 2019). Similarly, experimental research indicates that graphic organizers improve reading comprehension by helping learners structure textual information and recognize conceptual connections within texts (Heidarifard, 2014; Ayiz & Hidayatulloh, 2024).

Furthermore, cluster technology promotes active learning in the classroom. When students create visual representations of texts, they must analyze textual content, identify key concepts, and determine relationships among ideas. This process encourages learners to engage in higher-order cognitive activities such as analysis, synthesis, and organization of information. Previous

research has also demonstrated that mind mapping strategies enhance learners' cognitive engagement and critical thinking during language learning tasks (Wang, 2020; Debbag et al., 2021).

Overall, the findings suggest that cluster technology serves as an effective cognitive tool that supports students in organizing textual information and constructing meaning during reading activities. By transforming linear textual information into structured visual representations, cluster-based strategies help learners process complex texts more efficiently and develop stronger reading comprehension skills.

### **Conclusion**

This study demonstrates that cluster technology represents an effective methodological approach for enhancing students' English reading skills in EFL contexts. The findings indicate that students who engaged in cluster-based reading activities showed noticeable improvement in their ability to identify main ideas, recognize relationships between concepts, and organize textual information logically. By transforming linear textual information into visual conceptual structures, cluster-based strategies enable learners to process reading materials more systematically and develop stronger comprehension skills. These results are consistent with previous studies indicating that visual mapping strategies can significantly enhance reading comprehension and knowledge organization in language learning environments (Nesbit & Adesope, 2006; Rassaei, 2019).

The study also highlights the pedagogical value of visual learning strategies in reading instruction. The use of mind maps, concept maps, and graphic organizers encourages active engagement with textual information and helps learners construct meaningful connections among ideas. Such strategies support deeper cognitive processing and facilitate the integration of new information with existing knowledge structures, which is

essential for effective reading comprehension (Novak, 2010; Han, 2025).

From a pedagogical perspective, the findings suggest that integrating cluster technology into EFL reading instruction can promote student-centered learning and improve learners' strategic reading abilities. Teachers are therefore encouraged to incorporate visual mapping activities into reading lessons in order to help students analyze textual structures and organize information more effectively. Visual clustering strategies can serve as practical instructional tools that support learners in understanding complex texts and developing independent reading skills.

Future research should explore the integration of digital mapping tools and emerging educational technologies to further enhance the effectiveness of cluster-based reading instruction. In particular, studies could investigate how computer-assisted concept mapping systems and collaborative digital learning environments influence students' reading comprehension and cognitive engagement (Liu, Chen, & Chang, 2010; Mancao & Dequito, 2022). Such research may contribute to the development of innovative instructional models that combine visual learning strategies with technology-supported language education.

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