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From Brainstorming to Argumentation: Mind Mapping as Cognitive Scaffolding for Critical EFL Writing in Vocational

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Abstract

This study examined the function of mind mapping as cognitive scaffolding in improving critical thinking abilities and analytical exposition writing performance among vocational EFL students. The study examined the extent to which mind mapping techniques enhanced students' critical thinking and writing performance, as well as students' perceptions of the strategy's application during the writing process. A sequential explanatory mixed-methods design was utilized, comprising 34 eleventh-grade vocational students allocated into experimental and control groups. Quantitative data were gathered via pretest and posttest analytical exposition writing assignments evaluated using writing and critical thinking rubrics, and qualitative data were acquired through semi-structured interviews with chosen participants. The quantitative data were examined using descriptive statistics, paired sample t-tests, independent sample t-tests, and Cohen's d effect size analysis, while the qualitative data were assessed by thematic analysis. The results indicated that students utilizing mind mapping techniques exhibited superior enhancement in critical thinking abilities and writing proficiency relative to those subjected to traditional teaching methods. Qualitative research revealed that mind mapping improved concept organization, persuasive reasoning, writing confidence, and classroom participation, although initial hurdles associated with brainstorming and time management. The findings indicate that mind mapping serves as an effective visual cognitive framework that enhances higher-order thinking and the development of argumentative writing in vocational EFL settings.

Keywords: *Analytical Exposition Writing; Cognitive Scaffolding; Critical Thinking; Mind Mapping; Vocational EFL Education*.

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Introduction

The instruction of English as a Foreign Language (EFL) has increasingly emerged as a pivotal issue in global education systems, as it signifies not only students' linguistic proficiency but also their capacity for critical thinking, logical organization of ideas, and effective communication of arguments in academic and professional settings. In the 21st century, writing training transcends mere grammatical precision and vocabulary mastery, focusing instead on higher-order cognitive processes including analysis, evaluation, interpretation, and reasoning (David & Anderson, 2022; Oo & Okada, 2024; Singh, 2025). This transition is closely associated with modern educational reforms that advocate for critical thinking, creativity, communication, and teamwork as vital skills for future learners. Arum et al. (2025), Hunaepi & Suharta (2024), and Maifah et al. (2025) assert that in Indonesia, these expectations are manifested in the execution of Kurikulum Merdeka, which promotes student-centered learning and the incorporation of deep learning methodologies across disciplines, including English instruction. In vocational education contexts, these expectations present considerable pedagogical obstacles, as students are frequently prepared mostly for technical and occupational skills rather than for argumentative academic literacy.

Among the diverse genres instructed in EFL classes, analytical exposition writing is especially challenging as it necessitates students to formulate assertions, present logical arguments, assess evidence, and convincingly persuade readers. Writing assignments inherently necessitate critical thinking skills. In this study, critical thinking denotes learners' capacity to interpret information, analyze links among concepts, assess arguments, draw inferences, and systematically articulate reasoning (Kirsan & Yiğitoğlu, 2026; Quitadamo & Kurtz, 2007; Suteja & Setiawan, 2022). Mind mapping is a visual technique that allows learners to produce, arrange, and link ideas through branching conceptual frameworks prior to writing (Hidayati et al., 2023; SEBİT & Yıldız, 2020). For instance, prior to composing an analytical exposition regarding the influence of social media on students' learning behaviors, students can initiate the process by positioning the central topic within a diagram and thereafter extending supporting arguments, counterarguments, examples, and evidence outside. This approach enables students to visualize logical linkages among concepts before converting them into clear written arguments.

Mind mapping is theoretically linked to cognitive learning theory and constructivist viewpoints that highlight significant learning by active knowledge organization (Cheng, 2012; Morsi & Sivakami, 2025; Yan et al., 2022). Numerous studies have investigated the educational efficacy of mind mapping in language acquisition settings. In a study, researchers examined the impact of mind mapping on the writing organization of secondary EFL students through a quasi-experimental design and discovered that students utilizing mind maps generated more coherent and logically structured essays compared to those receiving conventional instruction (Elsa, 2025; Nguyen & Phan, 2025; Rababah & Alshunnaq, 2023). The results indicated that visual idea organizing aided learners in the pre-writing phase by alleviating cognitive overload and enhancing idea formation.

In a similar vein, another study investigated the impact of digital mind mapping on the argumentative writing performance of university EFL learners through classroom action research (Hidayat et al., 2024; Naghmeh-Abbaspour & Rastgoo, 2020; SEBİT & Yıldız, 2020). The findings indicated enhancements in content elaboration, coherence, and organization following multiple intervention cycles. The research indicated that mind

mapping served as a cognitive scaffold, assisting learners in organizing intricate arguments. In a separate study, researchers analyzed the association between critical thinking training and writing quality in EFL students by correlational analysis (Alwehaibi, 2012; Azizifard, 2025; Nejmaoui, 2018). Their findings indicated that pupils exhibiting elevated critical thinking skills were more likely to generate analytical and compelling written works, suggesting a substantial correlation between writing quality and cognitive reasoning capabilities.

Research has emphasized the significance of mind mapping in improving critical thinking abilities. A mixed-methods study on blended learning settings revealed that mind mapping enhanced students' ability to understand conceptual linkages and synthesize knowledge more effectively during writing assignments (Alderbashi & Moussa, 2022; Daeng & Enre, 2024; Yarmi et al., 2025). Similarly, a study contrasting mind mapping with concept mapping indicated that both techniques positively influenced learners' skills in interpretation, evaluation, and inference, although students found mind mapping to be more engaging and accessible (Hazaymeh & Alomery, 2021; Le et al., 2023; Murtiningsih et al., 2022). These data suggest that visual learning tools may enhance cognitive engagement during writing tasks.

Conversely, numerous research have shown constraints in the application of mind mapping techniques. Certain studies indicated that students first encountered difficulties in creating good visual diagrams due to their inexperience in visually arranging abstract concepts (Juniarti et al., 2025; Keleş, 2012; Yan et al., 2022). Other research primarily concentrated on general secondary or higher education environments rather than vocational institutions, despite vocational learners frequently exhibiting distinct academic requirements and learning traits. Moreover, prior studies have often investigated writing performance or critical thinking in isolation, neglecting to analyze the simultaneous interaction of both categories within argumentative writing instruction (Normore et al., 2024; Pei et al., 2017).

Collectively, current research indicates that mind mapping can enhance concept organization, cognitive engagement, and writing proficiency in EFL settings (Karim et al., 2021; Zhang, 2018). Prior research consistently demonstrates that learners gain from visual scaffolding during pre-writing tasks, since it facilitates the systematic organization of ideas and the formulation of more robust arguments. Research has demonstrated a significant correlation between critical thinking and the quality of argumentative writing, indicating that effective writing teaching ought to concurrently incorporate cognitive and linguistic development. Furthermore, favorable student impressions of mind mapping suggest that visual methods may enhance involvement and confidence in intricate writing assignments.

Notwithstanding these significant contributions, numerous gaps remain inadequately addressed. Empirical research concentrating on vocational EFL education are scarce, especially in Indonesian contexts where vocational institutions prioritize technical skills above the cultivation of argumentation literacy. Secondly, numerous research have exclusively utilized quantitative methods, providing little insight into how students perceive and interpret mind mapping during the writing process. Third, previous studies frequently regarded mind mapping solely as a brainstorming method, rather than as a cognitive scaffold that facilitates higher-order reasoning and the creation of arguments. These limitations are significant as vocational students often struggle with language precision, structuring arguments, assessing concepts, and maintaining logical coherence in writing assignments. In the absence of systematic cognitive assistance, pupils' writing may persist as descriptive rather than analytical.

This study seeks to examine the function of mind mapping as cognitive scaffolding in enhancing students' critical thinking abilities and analytical exposition writing performance in vocational EFL classrooms. This study specifically examines the following research question: (1) Does the implementation of mind mapping considerably enhance students' critical thinking abilities in analytical exposition writing? Does the implementation of mind mapping substantially enhance students' writing proficiency? What are students' perceptions of the adoption of mind mapping tools in analytical exposition writing activities? The study posits that pupils instructed with mind mapping procedures will exhibit markedly greater enhancements in critical thinking and writing ability than those subjected to traditional teaching methods.

The study used an explanatory sequential mixed-methods design with two interrelated phases to achieve these objectives. The quantitative phase employs a quasi-experimental non-equivalent control group pretest–posttest design to assess the impact of mind mapping strategies on students' critical thinking abilities and writing performance. This phase is succeeded by a qualitative component that entails semi-structured interviews with chosen students to elucidate and interpret the quantitative results. This design investigates the efficacy of mind mapping and assesses learners' experiences with the method during the writing process. Students exposed to mind mapping are expected to exhibit enhanced argumentative organization, better reasoning patterns, and increased writing coherence as a result of the structured visualization of concepts.

This research offers both theoretical and practical contributions to EFL writing teaching in multiple aspects. Theoretically, it enhances discourse on cognitive scaffolding by framing mind mapping as a strategic tool that facilitates persuasive reasoning and higher-order thinking in writing. It also enhances the expanding literature linking visual learning methodologies to the advancement of critical literacy in EFL environments. The study offers evidence-based insights for educators and curriculum creators aiming to enhance critical writing training in vocational education. This study presents a pedagogically applicable paradigm for enhancing deeper learning by combining cognitive and linguistic dimensions in analytical exposition writing, in accordance with 21st-century educational requirements.

Research Methods

1. Research types

This research utilized an explanatory sequential mixed-methods design (QUAN → qual) derived from Creswell's mixed-methods framework (Author, Year). The design incorporated both quantitative and qualitative stages to achieve a thorough understanding of the efficacy of mind mapping tools in EFL writing training. The quantitative phase employed a quasi-experimental design with a non-equivalent control group, utilizing pretest and posttest measures for both experimental and control groups. The instructional sequence comprised pretest, treatment, and posttest procedures. Mind mapping procedures acted as the independent variable, whereas students' critical thinking abilities and writing proficiency were the dependent factors. Following this, qualitative follow-up interviews were performed to investigate students' attitudes and elucidate the quantitative results more thoroughly.

2. Research Setting and Participants

This research was carried out in UPTD SMKN 1 Polewali, West Sulawesi, Indonesia, in the second semester of the 2025/2026 academic year. The study was

conducted over three weeks, comprising six educational sessions. The group consisted of all Grade XI students under the vocational education (SMK) framework, where English instruction prioritized both academic and professional communication abilities. Cluster random sampling was employed to choose intact classrooms based on practical teaching requirements. The experimental group comprised Class XI DKV 2 (17 students) who received Mind Mapping training, whilst Class XI AKL 1 (17 students) functioned as the control group with traditional instruction. Qualitative subjects were intentionally chosen according to their levels of improvement: high, moderate, and poor.

Table 1. Distribution of Research Participants and Instructional Treatment

Category	Number of Students	Instructional Treatment
Experimental Group (XI DKV 2)	17	Mind Mapping Strategies
Control Group (XI AKL 1)	17	Conventional Instruction
Interview Participants - High Improvement	3	Semi-Structured Interview
Interview Participants - Moderate Improvement	3	Semi-Structured Interview
Interview Participants - Low Improvement	3	Semi-Structured Interview

Table 1 illustrates the distribution of participants engaged in both the quantitative and qualitative phases of the study. The experimental and control groups comprised equal numbers of vocational students to ensure instructional balance and comparability. Qualitative participants were intentionally chosen depending on their levels of improvement to offer deeper insights into students' experiences during the application of Mind Mapping. The participant structure embodies an explanatory sequential mixed-methods design, facilitating the amalgamation of statistical results with comprehensive qualitative insights pertaining to cognitive engagement and writing development.

3. Research Instruments, Validity, and Reliability

This study utilized both quantitative and qualitative methods to gather extensive data regarding students' critical thinking abilities and writing proficiency. The quantitative instruments were pretest and posttest analytical exposition writing assignments evaluated using writing rubrics that addressed organization, coherence, content development, grammar, and vocabulary. Critical thinking was assessed with a rubric derived from Facione's framework, encompassing interpretation, analysis, assessment, inference, explanation, and self-regulation on a five-point analytic scale. Observation checklists assessed instructional uniformity and student engagement. Semi-structured interviews examined students' experiences, involvement, perceived advantages, and obstacles associated with mind mapping. Instrument validity was determined via expert evaluation, whereas reliability encompassed inter-rater scoring consistency, member validation, triangulation, dependability protocols, and researcher impartiality during qualitative analysis.

4. Data Collection Procedures and Data Analysis Techniques

The study commenced with preparatory processes, which involved securing school authorization, validating research instruments, and preparing lesson plans. In the quantitative phase, pretests were conducted to assess students' initial writing proficiency

and critical thinking abilities, succeeded by six instructional sessions contrasting the techniques of the experimental and control groups. Posttests were administered to ascertain enhancement following the intervention. Qualitative participants were subsequently chosen based on their levels of improvement for semi-structured interviews, which were videotaped and transcribed. Quantitative data were examined utilizing descriptive statistics, Shapiro–Wilk normality tests, Levene's homogeneity tests, paired and independent sample t-tests, and Cohen's d effect size assessment. The qualitative interview data were examined using Braun and Clarke's thematic analysis, which encompassed coding, theme identification, interpretation, and integration with quantitative results.

5. Ethical Considerations

This work complied with essential research ethics criteria during the inquiry procedure. All subjects granted informed consent and engaged voluntarily without compulsion. Confidentiality and anonymity were preserved through the utilization of coded participant identities in all datasets and reports. The writing scores of students and interview transcripts were securely archived to guarantee data protection and confidentiality. Moreover, academic integrity was upheld by impartial scoring methods, uniform assessment standards, and equitable interpretation of both quantitative and qualitative results throughout the investigation.

Results and Discussion

Result

1. Overview of the Findings

This section delineates the findings derived from both the quantitative and qualitative phases of the study regarding the application of Mind Mapping Strategies in analytical exposition writing among vocational EFL students. The results are structured according to the research objectives, questions, and hypotheses established in prior chapters. The quantitative results concentrate on assessing the impact of mind mapping on students' critical thinking abilities and writing performance via descriptive and inferential statistical analyses, encompassing paired sample t-tests, independent sample t-tests, and effect size evaluation. The qualitative findings examine students' opinions, experiences, and participation during the strategy's implementation via semi-structured interviews. In accordance with the explanatory sequential mixed-methods design, the qualitative phase was executed subsequent to the quantitative analysis to elucidate and reinforce the statistical results. The study examined whether Mind Mapping Strategies significantly enhanced students' critical thinking abilities and analytical exposition writing performance in comparison to traditional instructional methods.

2. Quantitative Results

The quantitative results of this study were derived from pretest and posttest scores assessing students' critical thinking abilities and writing competence in analytical exposition writing. Descriptive statistical analysis encompassed mean scores, standard deviations, minimum scores, and maximum scores for both the experimental and control groups. The results revealed that the experimental group exhibited superior enhancement following the application of Mind Mapping Strategies in contrast to the control group. During the pretest period, both groups shown similar levels of achievement. Nonetheless, the posttest outcomes demonstrated significant enhancement in the experimental group, especially for students' proficiency in structuring arguments,

assessing concepts, and producing cohesive written compositions. The findings indicated favorable trends in students' critical thinking proficiency and analytical writing ability following the educational intervention.

Before doing inferential analysis, assumption testing was performed with the Shapiro–Wilk normality test and Levene's homogeneity test. The normality results demonstrated that the data were predominantly normally distributed, whereas the homogeneity test validated the equality of variances among groups. The results indicated that the data satisfied the prerequisites for parametric statistical analysis.

Moreover, paired sample t-tests indicated a substantial enhancement in critical thinking skills and writing competence within the experimental group following the treatment. Conversely, the control group exhibited minimal or statistically negligible enhancement after traditional education. Independent sample t-tests revealed significant changes in posttest achievement between the experimental and control groups, indicating the efficacy of Mind Mapping Strategies as cognitive scaffolding in EFL writing teaching.

Ultimately, effect size analysis employing Cohen's d revealed medium to large effect sizes, signifying that the educational intervention had considerable practical importance in enhancing students' critical thinking abilities and analytical exposition writing competence.

Table 2. Descriptive Statistics of Critical Thinking and Writing Performance

Group	Critical Thinking Mean	Writing Performance Mean	Std Deviation	Minimum	Maximum
Experimental Pre	50.82	50.82	12.709	36	68
Experimental Post	62.35	62.35	14.426	36	84
Control Pre	60.47	60.47	8.931	44	72
Control Post	59.76	59.76	14.455	36	80

Table 2 displays the descriptive statistical outcomes of students' critical thinking abilities and writing proficiency in both experimental and control groups. The results indicate that the experimental group exhibited superior post-test enhancement following the application of Mind Mapping Strategies. The rise in average scores and peak performance signifies enhanced proficiency in analytical thinking and the structure of argumentative writing. Conversely, the control group exhibited no advancement following traditional instruction, indicating that visual cognitive scaffolding positively influenced students' academic writing skills.

Figure 1. Comparative Development of Critical Thinking and Writing Performance

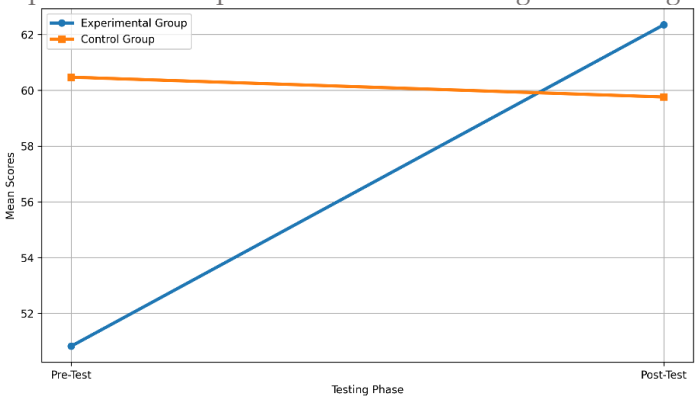

Figure 1 depicts the comparative growth trajectories of the experimental and control groups during the pre-test and post-test phases. The experimental group exhibited a significant upward trajectory after the application of Mind Mapping Strategies, signifying enhancement in critical thinking and analytical writing capabilities. Conversely, the control group exhibited consistent performance with negligible advancement. The visualization illustrates how organized visual brainstorming activities can enhance cognitive organization, argument formulation, and advanced reasoning skills in vocational EFL writing education.

Figure 2. Achievement Distribution Profile in Post-Test Performance

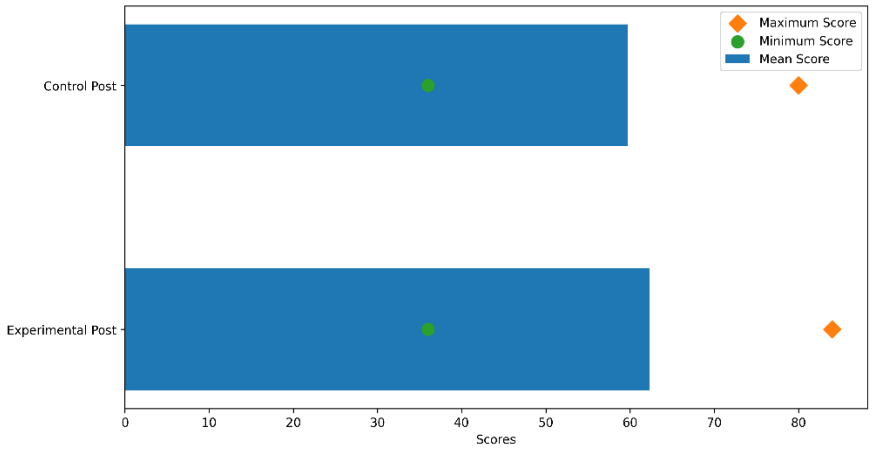

Figure 2 illustrates a comparative distribution profile of achievements based on post-test performance metrics. The experimental group attained superior mean and maximum scores compared to the control group following Mind Mapping instruction. The visualization further illustrates a considerable enhancement in the quality of argumentative writing and critical thinking results. The findings indicate that cognitive scaffolding via visual mapping allowed students to systematically organize concepts and generate more robust analytical exposition texts than traditional instructional methods in vocational EFL classrooms.

Figure 3. Variability and Score Dispersion Across Groups

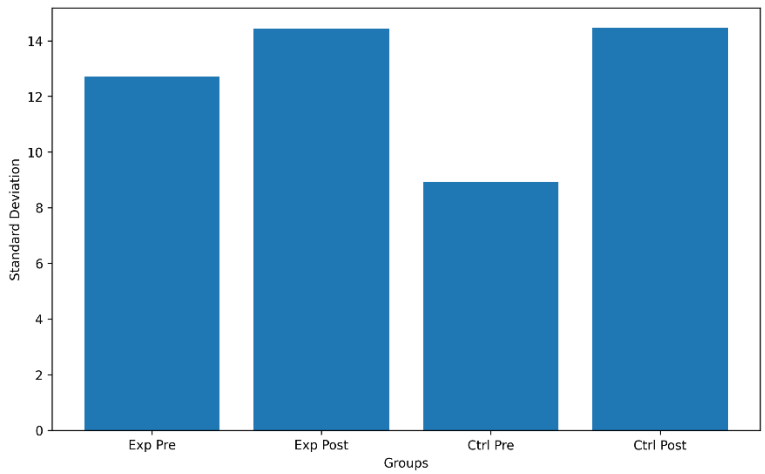

Figure 3 illustrates the distribution and variability of student scores via standard deviation analysis across teaching groups and assessment phases. The experimental group exhibited regulated score variability and superior overall performance following the treatment period. This pattern signifies a more constant enhancement in learning subsequent to the use of Mind Mapping Strategies. Conversely, the control group had greater variability following traditional instruction, indicating uneven learning results. The image underscores the significance of structured visual scaffolding in stabilizing and improving students' writing performance development.

3. Qualitative Results

The qualitative phase comprised semi-structured interviews with chosen people from the experimental group, categorized into high, moderate, and low improvement based on post-test performance. The objective of the qualitative investigation was to elucidate and reinforce the quantitative results pertaining to the application of Mind Mapping Strategies in analytical exposition writing. The interview results identified four primary themes concerning students' learning experiences, cognitive engagement, and writing growth.

The initial theme recognized mind mapping as a mechanism for organizing ideas. Students articulated that visual diagrams facilitated the methodical organization of arguments and enhanced the clarity of supporting concepts prior to writing. Numerous participants indicated that branching notions facilitated the logical structuring of analytical exposition materials. These data suggest that mind mapping served as visual scaffolding, alleviating cognitive overload throughout the writing process.

The second subject concentrated on the augmentation of critical thinking processes. Students indicated that mind mapping facilitated deeper analysis of issues, assessment of links among concepts, and the formulation of more robust arguments. The interview extracts indicated that cognitive engagement heightened when students visually examined the relationships between statements and supporting evidence.

The third focus emphasized enhanced writing confidence and classroom participation. Students demonstrated increased confidence in articulating ideas and engaging in writing tasks following the use of mind mapping techniques. The visual brainstorming technique alleviated anxiety and enhanced motivation during argumentative writing assignments.

The fourth theme disclosed other issues, such as obstacles in initial brainstorming, the organization of intricate ideas, and time constraints during classroom exercises. The data indicate that students necessitated adjustment and ongoing support when employing visual cognitive techniques. The qualitative findings corroborated the quantitative results by illustrating that Mind Mapping Strategies served as effective cognitive scaffolding, hence enhancing critical thinking development and analytical writing ability in vocational EFL classrooms.

Table 2. Dominant Themes Emerging from Students' Interview Responses

Theme	Frequency of Responses	Interpretation
Idea Organization	14	Visual structuring improved argument organization
Critical Thinking Enhancement	13	Mind mapping enhanced analysis and reasoning

Writing Confidence and Engagement	15	Students became more confident and engaged
Challenges in Mind Mapping	8	Some students struggled with brainstorming and time management

Table 2 delineates the predominant qualitative themes derived from students' interview replies following the application of Mind Mapping Strategies. The results reveal that the structuring of ideas and writing confidence were the most commonly addressed experiences among participants. Students regarded visual mapping as an efficacious method for structuring ideas and enhancing participation in analytical exposition writing. Despite the identification of several barriers, the overall replies indicated favorable cognitive and emotional experiences linked to mind mapping activities in vocational EFL classrooms.

Figure 4. Dominant Themes Emerging from Students' Interview Responses

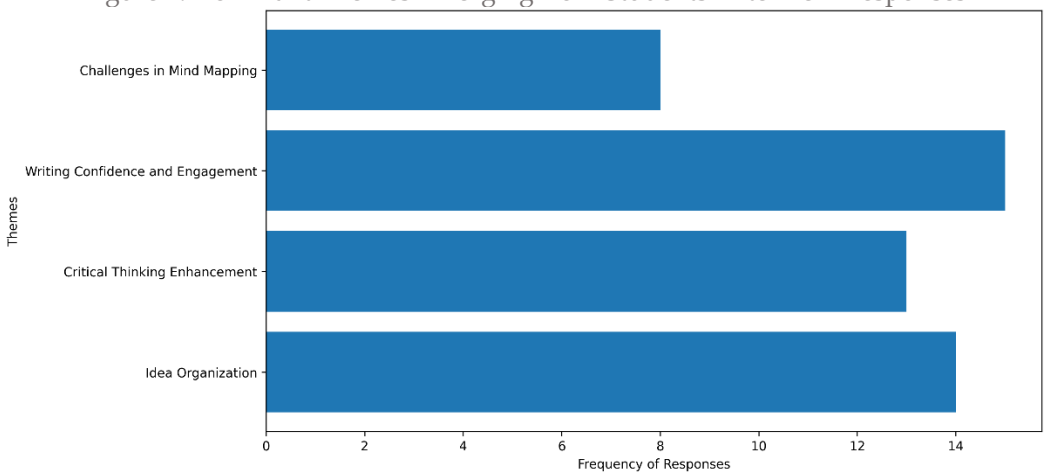

Figure 4 depicts the frequency distribution of principal themes identified by the thematic analysis of interview data. The visualization indicates that writing confidence, concept organization, and the strengthening of critical thinking were prevalent themes regularly cited by students following their engagement in Mind Mapping activities. Conversely, issues associated with brainstorming and time management seemed less prominent. The findings demonstrate that visual cognitive scaffolding positively affected students' engagement, reasoning processes, and argumentative writing experiences in vocational EFL learning contexts.

Figure 5. Cognitive and Affective Engagement Profile in Mind Mapping Activities

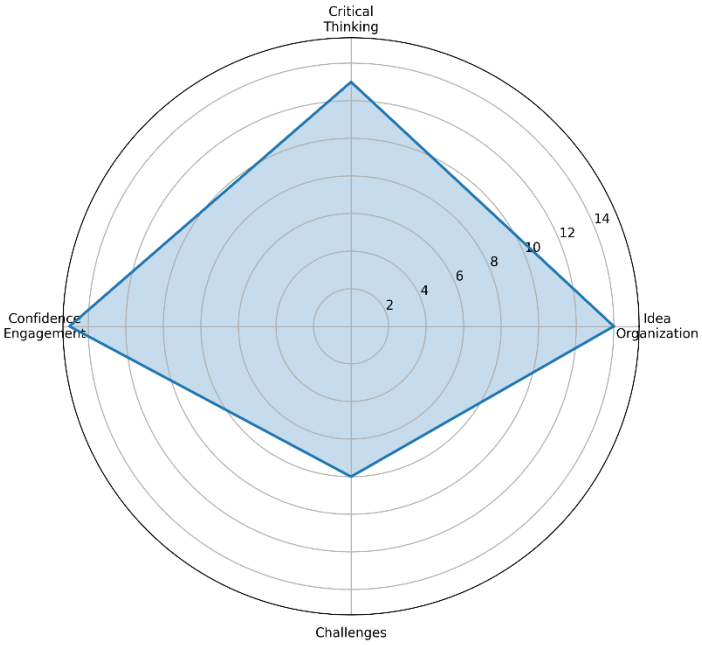

Figure 5 displays a radar chart illustrating students' cognitive and emotional engagement during the application of Mind Mapping. The figure illustrates significant involvement in concept structuring, the strengthening of critical thinking, and increased writing confidence, suggesting that students actively engaged with visual brainstorming techniques throughout analytical exposition writing tasks. Simultaneously, obstacles emerged at a diminished intensity, indicating that the majority of pupils acclimated favorably to the instructional approach. The image underscores the function of Mind Mapping as cognitive scaffolding in EFL argumentative writing pedagogy.

Discussion

The results demonstrate that mind mapping functioned as an effective cognitive framework for enhancing students' critical thinking abilities and analytical writing ability in a vocational EFL setting. Students instructed by mind mapping demonstrated superior proficiency in concept organization, argument construction, and confident engagement with writing assignments compared to their peers receiving traditional teaching. The qualitative data elucidated that students saw mind mapping as beneficial for visualizing concepts, alleviating confusion during pre-writing, and facilitating argument formulation. Consequently, the research questions received general support, and the hypotheses regarding the beneficial impact of mind mapping on critical thinking and writing performance were affirmed.

The enhancement in critical thinking indicates that mind mapping prompted students to progress from merely listing ideas to analyzing the interconnections among concepts. In analytical exposition writing, students must establish a stance, construct supporting arguments, and present logical reasoning. Mind mapping seems to have facilitated these processes by rendering abstract thinking more tangible. By utilizing central concepts, branches, keywords, and supporting facts, students can identify subjects, examine relationships, assess pertinent arguments, and formulate conclusions prior to drafting (Daeng & Enre, 2024; Robillos & Art-in, 2023; Rosen & Tager, 2014).

This corresponds with Facione's critical thinking framework, specifically the elements of interpretation, analysis, inference, explanation, and self-regulation. The intervention integrated critical thinking into the writing process rather than treating it as

a distinct talent. The enhancement in writing performance can be attributed to the function of mind mapping as a pre-writing framework. Numerous EFL learners encounter difficulties not solely because to restricted vocabulary or grammar, but also due to an absence of a coherent strategy for content organization. Mind mapping assisted students in organizing their thesis, arguments, and reiterations prior to drafting the final text (Fu & Relyea, 2024; Naqbi, 2011; Tarin & Yawiloeng, 2023). Consequently, writing evolved to be less arbitrary and more intentional. This discovery corroborates the process-based writing theory, which conceptualizes writing as a recursive sequence of planning, drafting, rewriting, and reflecting. In this study, the planning phase became more cognitively engaging when students were instructed to convert brainstorming into an argumentation framework.

The qualitative findings provide a significant explanatory dimension. Students' feedback suggested that mind mapping enhanced confidence and interest by providing a tangible framework for writing. This indicates that the method was effective both cognitively and affectively. Students felt more equipped to write when they could visualize their ideas systematically on paper. This diminished anxiety and enhanced involvement. These findings are significant in vocational EFL courses, where students may exhibit diminished confidence in academic English writing due to restricted exposure to argumentative genres (Chen & Mah, 2024; Robillos & Art-in, 2023). Mind mapping served as a conduit between students' pre-existing concepts and the linguistic requirements of analytical exposition.

These findings align with other research indicating that mind mapping enhances idea development, coherence, and structure in EFL writing (Author, Year). They also endorse research indicating that visual learning aids can improve critical thinking by assisting learners in analyzing and synthesizing knowledge (Robillos & Art-in, 2023; Tarin & Yawilong, 2022; Yen, 2024). This research corroborates findings on cognitive scaffolding, demonstrating that learners gain advantages when intricate activities are divided into discernible, manageable phases. This study builds upon previous research by contextualizing mind mapping within Indonesian vocational education, an area that is still inadequately covered in EFL writing studies (Robiana et al., 2026; Rosita & Halimi, 2023). In contrast to regular secondary or university students, vocational learners typically engage with curriculum that emphasize technical skills. The current findings indicate that argumentative literacy and higher-order thinking can be enhanced through writing instruction that incorporates structured visual tactics.

The findings must be interpreted with cautious scrutiny. Several students encountered challenges in creating mind maps, particularly in the first phases of brainstorming and structuring intricate concepts. This suggests that mind mapping is not inherently successful only due to its visual nature. Students want clear modeling, directed practice, and constructive feedback to utilize the method effectively. In the absence of such support, mind maps may transform into ornamental rather than analytical tools. This partially elucidates why certain prior studies indicated inconsistent effects of mind mapping on writing performance (Eaton, 2023; Le et al., 2023). Variations in teacher leadership, treatment duration, students' past exposure to visual learning, and assessment criteria may affect the degree to which mind mapping yields significant learning advancements.

This work theoretically enhances EFL writing teaching by framing mind mapping as cognitive scaffolding rather than simply a brainstorming method. Its significance resides in assisting students in externalizing thoughts, structuring reasoning, and converting conceptual relationships into written arguments. The research further

reinforces the correlation between critical thinking and writing proficiency, indicating that enhanced writing may result when students are encouraged to engage in more systematic thought prior to drafting. In this regard, writing development encompasses both linguistic and cognitive dimensions.

The findings indicate that English instructors at vocational schools may incorporate mind mapping into analytical exposition writing sessions to enhance students' planning, reasoning, and organizational skills. Educators ought to progressively implement mind mapping, furnish examples of proficient maps, assist pupils in correlating assertions with evidence, and employ peer discourse to enhance concepts prior to writing. The findings advocate for curriculum authors to incorporate visual and student-centered methodologies that match with Kurikulum Merdeka and 21st-century competences. Mind mapping can facilitate the operationalization of critical thinking in educational practice by transforming abstract curriculum objectives into tangible writing tasks.

Limitations and Future Research

Numerous constraints must be recognized. The study utilized a limited sample from a single vocational institution, hence constraining the generalizability of the results. The treatment was administered over a restricted instructional duration, complicating the assessment of long-term effects. The study exclusively examined analytical exposition writing; varying genres may yield disparate results. The prior familiarity of pupils with mind mapping was not adequately controlled, potentially affecting their adaption to the approach. Ultimately, while interviews enhanced the analysis, qualitative data were exclusively obtained from specific individuals inside the experimental group.

Subsequent research should encompass larger and more heterogeneous groups from vocational schools across other geographies. Longitudinal study is necessary to investigate if mind mapping yields enduring enhancements in critical thinking and writing quality. Subsequent research might analyze the differences between manual and digital mind mapping tools, explore AI-enhanced visual brainstorming, or assess the impact of mind mapping on other genres, including argumentative essays, reports, and project-based writing. Future research could further investigate teacher mediation, as instructional guidance seems pivotal to the efficacy of mind mapping.

This study illustrates that mind mapping can significantly facilitate the transition from brainstorming to argumentation in vocational EFL writing. The method facilitated the visibility of thought, enabling pupils to organize ideas, engage in critical reasoning, and compose more coherently. Its importance resides not just in enhancing writing results but also in demonstrating how visual cognitive scaffolding can fortify higher-order learning in circumstances where academic writing has frequently posed difficulties

Conclusion

This study investigated the function of mind mapping as cognitive scaffolding in enhancing the critical thinking abilities and analytical exposition writing performance of vocational EFL students. The study aimed to ascertain the effectiveness of mind mapping by integrating both quantitative and qualitative methodologies, while also exploring students' experiences with the tactic during the writing process.

The results indicate multiple significant outcomes. Initially, mind mapping substantially facilitated the enhancement of students' critical thinking abilities by assisting learners in analyzing situations, structuring arguments, and systematically connecting concepts prior to writing. The technique enhanced students' performance in

analytical exposition writing, notably for structure, coherence, and argumentation growth. Third, qualitative findings indicated that students viewed mind mapping favorably as it enhanced idea development, diminished confusion during brainstorming, and bolstered confidence in articulating arguments. The amalgamation of quantitative and qualitative findings substantiated that visual cognitive scaffolding enhanced involvement in the writing process. The findings substantiate the notion that mind mapping serves as an effective teaching approach for improving both cognitive and linguistic aspects of EFL writing in vocational education settings.

The research theoretically advances the discourse on cognitive scaffolding and process-oriented writing teaching in EFL settings. It illustrates that enhancement in writing is intricately linked to organized cognitive processes rather than solely to linguistic proficiency. The study provides evidence-based implications for English educators, curriculum designers, and vocational education professionals pursuing student-centered methodologies consistent with 21st-century learning objectives. Incorporating mind mapping into writing education may enhance students' analytical reasoning, improve argument organization, and foster greater engagement in classroom learning.

Subsequent research should encompass bigger and more heterogeneous participant cohorts, investigate the enduring impacts of teaching, and assess the incorporation of digital or AI-enhanced mind mapping tools across various writing genres and educational contexts.

Author Contribution Statement

Author 1 acted as the initiator and conceptor of the article; Author 2 contributed to the analysis and interpretation of the data; Author 3 served as the validator of the data and analysis results; Author 4 contributed to the data collection and critical revision of the article. All authors approved the final content of the article and are responsible for all aspects of this research.

Statement of Interest

All authors declare that they have no financial or non-financial conflicts of interest relevant to this research.

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