




# Integrating Digital Cognitive Mapping into Speaking Instruction: A Quasi-Experimental Study with Indonesian EFL Students

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## Abstract

**Background of study:** Speaking is a fundamental component of communication skills for English as a Foreign Language (EFL) students. Nevertheless, many learners encounter difficulties in expressing ideas fluently and coherently in oral communication. These challenges highlight the need for instructional strategies that facilitate idea generation, organization, and delivery through technology-enhanced learning environments.

**Aims:** This study aims to examine the effect of integrating digital cognitive mapping into speaking instruction on the speaking performance of Indonesian EFL university students.

**Methods:** A quasi-experimental pretest–posttest control group design was employed involving 44 students enrolled in an English Language Education program. The participants were divided into an experimental group ( $n = 22$ ) and a control group ( $n = 22$ ). The experimental group received speaking instruction supported by digital cognitive mapping tools, while the control group engaged in conventional speaking activities without cognitive or digital mapping. Students' speaking performance was assessed using standardized speaking rubrics, and the data were analyzed using descriptive and inferential statistics.

**Result:** The results indicated that the experimental group showed a statistically significant improvement in speaking scores from pretest to posttest, whereas the control group demonstrated only a slight and non-significant gain. In addition, the experimental group significantly outperformed the control group on the posttest.

**Conclusion:** The study concludes that digital cognitive mapping is an effective instructional tool for enhancing EFL students' speaking performance, particularly in planning, organizing, and delivering oral texts. These findings support the integration of technology-enhanced, learner-centered speaking activities using visual knowledge-organization tools in higher education contexts.

## A. Introduction

The ability to speak English is a crucial productive skill that students in English Language Education programs must master, as it underpins academic success, employability, and participation in global communication (Chen & Hwang, 2020). In today's globalised world, speaking competence is required not

only for educational purposes but also for Involvement in international communication, professional collaboration, and lifelong learning, particularly in EFL contexts such as Indonesia (Zhang et al., 2024).

Despite its Significance, Many Indonesian university students continue to struggle with articulating their ideas clearly, concisely, and fluently. When speaking in English, they frequently struggle to maintain a logical flow of ideas, organize their thoughts, and use appropriate vocabulary, which suggests that their communicative needs remain unmet (Saputro, 2025). Teachers are more likely to prioritize their theoretical knowledge rather than speaking. Speaking exercises in many classrooms are still dominated by conventional teacher-centered techniques, such as drills, reading aloud, and repetition, which may not adequately foster the growth of higher-order Thinking and impromptu oral expression (Effendy & Taufik, 2023). As a result, students often produce disjointed and disorganized speech that does not accurately represent their actual knowledge and abilities. This situation highlights the urgent need to redesign speaking instruction to simultaneously increase learners' confidence, discourse organization, and linguistic accuracy (Ironsi & Bensen Bostanci, 2023). To address these issues, scholars and practitioners have emphasized the need for instructional strategies that can scaffold students' thought processes as they prepare and deliver spoken texts. One promising technique is cognitive mapping, sometimes known as concept mapping or mind mapping.

A cognitive map is a visual representation of the relationships between concepts, represented by nodes and lines or arrows connecting them. Learners can make connections across ideas, identify or highlight main and supporting details, and reorganize their thoughts in a way that creates unity by expressing their ideas visually (Han, 2025). Prior empirical studies and meta-analyses have shown that cognitive mapping enhances comprehension, critical Thinking, and retention across a variety of subjects and educational levels (Hwang et al., 2022). Cognitive mapping is particularly relevant to speaking abilities in the context of language learning because it motivates students to prepare the content and structure of their oral production before speaking. By creating maps before the performance, students can decide on the sequence of ideas, select key vocabulary, and predict transitions between different sections of their speech. This lessens cognitive load and facilitates more fluid delivery (Berta & Mulat, 2024). Recent research indicates that mind mapping and concept mapping techniques can improve students' confidence when using the target language in academic and professional settings, as well as in oral communication discourse organization (Tsai, 2025). The results suggest that cognitive mapping can lead to an improvement in speaking in EFL teaching. The advantages of these benefits are taken to the next level in digital cognitive mapping, utilizing computer and mobile applications for creating and updating concept maps.

Beyond practicality and ease of revision, digital cognitive mapping offers pedagogical advantages that paper-based mapping cannot fully provide, particularly in terms of synchronous collaboration and shared knowledge construction. Digital platforms allow learners to co-construct, edit, and reorganize cognitive maps in real time, enabling immediate negotiation of meaning, peer feedback, and collective decision-making during the planning stage of speaking tasks (Shadiev & Yang, 2020) (Shao et al., 2025). Such synchronous collaborative affordances are difficult to achieve with paper-based maps, which tend to limit interaction to individual or turn-based contributions rather than dynamic joint problem-solving. Through real-time collaboration, digital cognitive mapping supports social interaction, communicative scaffolding, and joint attention to discourse structure, all of which are essential for developing coherent and fluent oral production in EFL contexts (Chen & Hwang, 2024). Moreover, collaborative digital mapping environments promote shared responsibility and collective cognitive regulation, allowing learners to externalize ideas, monitor peers' contributions, and refine discourse organization collaboratively before speaking, thereby reducing cognitive load during oral performance (Li & Li, 2025).

In digital learning environments where cognitive maps are designed and manipulated, learners can also easily restructure content and ideas, work together on problems that are difficult to solve alone, and incorporate online (audio-visual) resources, which in turn may facilitate idea generation and language practice (Anas, 2022). In EFL contexts, empirical findings have also proven that when using digital mind-mapping applications, students can increase and improve their speaking performance 'over instructional cycles', decrease fear of speaking, and allow more ideas to flow during oral tasks (Trk & Kaj, 2023). While lessons learned from reviewing how ICT has been used in English teaching also highlight that technology-enhanced speaking learning can potentially enhance student motivation and engagement, while not been deployed systematically to develop cognitive strategies (Eryansyah & Erlina, 2023). Wider reviews of technology-enhanced language learning have placed a focus on the role played by digital tools and their impact, which are considered to be highly instrumental when integrated within well-grounded pedagogical frameworks conducive to planning, monitoring, and reflection rather than serving the purpose or role of a

displaying medium (Shadiev & Yang, 2020). Yet, while there is increasing evidence that both concept mapping and digital mind mapping may be beneficial for productive skills, research with experimental designs in which digital cognitive mapping is systematically embedded into speaking instruction at the tertiary level in Indonesian EFL contexts is limited (Mardhiah et al., 2024). This gap reflects the necessity of more quasi-experimental studies integrating cognitive-strategy training with ICT-based tools in order to measure learning gains, as well as to quantify the intensity of the intervention effect on speaking performance.

In the context of this background, the present study was conducted to investigate whether digital cognitive mapping can be used in teaching speaking to improve the language speaking ability of fourth-semester students majoring in English Language Education at Universitas PGRI Silampari. More specifically, it investigates whether learners who receive computer-aided speaking instruction using a digital cognitive map (DCM) show significantly more improvement in their speaking skills than those taught through conventional teaching strategies. Integrasi strategi metakognitif dengan alat digital terbukti meningkatkan kelancaran dan koherensi berbicara karena visual scaffolding membantu siswa merencanakan dan memonitor produksi bahasa secara lebih efektif (Paterson, 2022). Given that speaking is the focus of targeted productive skills and that semi-experimental console procedures are used in the research with respect to experimental orientations, this study aims to find reliable empirical evidence for pedagogical effectiveness in digital cognitive mapping for EFL higher education (Hsiao et al., 2023). The quasi-experimental nature of this study facilitates systematic group comparisons between learning results, from which the effect of digital cognitive mapping on fluency, coherence, lexicality, and confidence in speaking can be observed. Also, by adopting such a design, some of the restrictions that are common to in-class research in many contexts are released, leading to a stronger level of generalizability (Le, 2023). Previous studies have also found that digital mapping tools promote learner autonomy and decrease speaking anxiety, which can lead to a noticeable improvement in performance (Elov et al., 2025).

The findings are expected to contribute evidence on the feasibility of incorporating digital cognitive mapping into ICT-mediated oral production pedagogy, as well as practical implications for university teachers planning cognitively and technologically enhanced speaking tasks. Teachers can use digital cognitive maps as a pre-speaking planner, an invention of ideas during speaking sessions, or even as a post-speaking task to give a reflective activity, thus helping students visualize their thoughts and improve their communication (Okuyay & Zengin, 2025). In addition, digital cognitive mapping can help with differentiated instruction, allowing students to build, modify, and vet their models of speech structures at an enhanced level of accessibility for learners at different proficiency levels. The study therefore contributes to the broader dialogue about where technology-mediated learner-centred pedagogies should be heading if they are to accommodate the communicative needs of 21st-century EAP learners (Hadiyanto, 2024). With the increasing shift in global language learning to digital environments, incorporating tools such as digital cognitive mapping is consistent with current needs for adaptive, engaging, and cognition-rich teaching practices. These approaches contribute to the development of learners' digital literacy and deepen students' cognitive engagement and readiness for communication in today's world (Istikharoh & Utami, 2024). Thus, this study not only makes theoretical contributions but also provides practical implications for designing technology-based EFL learning environments.

In this study, the intervention was operationalized through student-generated digital cognitive maps that visually represented the structure of their oral texts, including the main topic, supporting ideas, examples, and concluding points. Illustrates an example of a digital cognitive map created by a student prior to delivering a speaking task, showing how ideas were hierarchically organized and interconnected using nodes, keywords, and directional links. The visual map demonstrates how students externalized their thinking by clustering related ideas, sequencing arguments, and marking transitional cues, which later served as a real-time reference during oral production.

Such visual evidence provides concrete proof of how digital cognitive mapping functioned not merely as a planning tool, but as an active cognitive scaffold supporting idea generation, discourse organization, and speaking fluency throughout the learning process.

## B. Research Methods

This research employed a quasi-experimental design with a non-equivalent control group pretest-posttest design. This design was then selected, given the inability to allocate participants into groups randomly. However, the availability of an experimental and a control group meant that instructional effects could still

be compared. The design aimed to determine whether cognitive mapping has a significant effect on students' speaking ability in English when compared with traditional methods.

The population in this study consisted of all fourth-semester students of the English Language Education Study Program at Universitas PGRI Silampari. Two intact classes that had completed the Speaking II class were chosen as a sample through purposive sampling. One class ( $n = 22$ ) was the experimental group that received cognitive mapping instructions, while the other class ( $n = 22$ ) served as the control group, which was trained using traditional speaking instructions. Participants were aged 19–22 and had relatively similar educational backgrounds. The full sample of 44 students was deemed sufficient for basic parametric statistical tests or t-tests. The students' speaking performance was measured using a pre- and post-test of speaking. The exam had students give a short speech or presentation on the subject area corresponding to their course. There was an analytic scoring rubric to evaluate their performance, focusing on speaking competencies such as fluency, accuracy, vocabulary, pronunciation, and organisation of ideas. Scores on the dimensions were added together to form a whole speaking score. The test and rubric were both reviewed by experts on education in the English language for content validity.

The experiment spanned over multiple speaking lessons. A pretest was conducted at the outset of the intervention in two conditions to assess participants' initial speaking skills. In the experimental condition, the teacher initially presented cognitive mapping itself as a concept and modelled how to construct maps of main idea and supporting detail/ logical relation in an oral presentation. Students learned to construct cognitive maps for themselves and in groups. The experimental group undertook cognitive mapping using both paper-based and digital tools. Students were provided with digital mind-mapping tools that can be used on laptops and smartphones. With the use of these ICT tools, students were able to easily add, delete, and reorder ideas for sense-making as they planned their speeches in collaboration with peers. In each speaking event, students created a mind map of the topic to be discussed and referred back to that map as they spoke. The teacher provided feedback on the quality of the maps and the students' oral performance as well. The control group, however, engaged in traditional speaking activities without the use of cognitive or digital mapping tools. Instruction was primarily the teacher's explanations, model dialogues, and speaking tasks, including role plays and individual talks. Students were invited to bring their ideas, but no systematic approach (e.g., cognitive mapping) was provided. At the conclusion of the intervention phase, a post-test that matched the pre-test in terms of format was administered to both groups to measure changes in speaking proficiency. Data analysis, descriptive and inferential statistics, analyzes the quantitative data. Descriptive statistics (mean, min and max values) of the pre-test and posttest are summarized for each group. In terms of inferential analysis, a paired samples t-test was run for the pretest and posttest speaking scores over pair levels in the experimental group (and another separate group). A comparison using a paired-samples t-test was done for the control. Furthermore, an independent-samples t-test was used to compare the experimental and control groups with regard to the posttest. For all t-tests, effect sizes were obtained via Cohen's  $d$  (with  $d \approx 0.2$  indicating a small effect,  $d \approx 0.5$  indicating a medium effect and  $d \geq 0.8$  an effective). The experimental group demonstrated a large effect size, while the control group displayed a small one. Statistical analysis: Statistical tests were conducted using the SPSS system.

## C. Results and Discussion

### 1. Results

The following tables summarise the pretest and posttest results for both groups. Overall, the data show a substantial gain in the experimental group following the use of digital cognitive mapping, whereas the control group exhibited only slight improvement under conventional speaking instruction.

Prior to conducting the inferential analyses, assumption testing was carried out to ensure the appropriateness of employing parametric statistics. The normality of the score distributions was examined using the Shapiro–Wilk test, which demonstrated that both the experimental and control groups' pretest and posttest scores were normally distributed (experimental pretest:  $W = 0.962$ ,  $p = .412$ ; experimental posttest:  $W = 0.971$ ,  $p = .528$ ; control pretest:  $W = 0.958$ ,  $p = .367$ ; control posttest:  $W = 0.968$ ,  $p = .489$ ), as all probability values exceeded the .05 threshold. In addition, the assumption of homogeneity of variances was verified through Levene's Test, which revealed no significant differences in variance between groups for either the pretest ( $F(1,42) = 1.38$ ,  $p = .247$ ) or posttest scores ( $F(1,42) = 0.94$ ,  $p = .338$ ). Taken together, these findings confirm that the data met the assumptions of normality and homogeneity, thereby providing statistical justification for the application of parametric procedures, specifically the paired-samples t-test and independent-samples t-test, in the subsequent analyses.

**Table 1.** Paired-Samples t-test in the Experimental Group

Variable	N	M (Mean)	(SD)	t(21)	p	d (Cohen's d)
Pretest	22	39.00	8.50			
Posttest	22	80.00	7.20	15.32	< .001	3.20

Notes:

- N = 22 (number of participants)
- M = mean score of speaking skill

SD = standard deviation

- t(21) = t-test value with degrees of freedom (df) = 21
- p < .001 indicates a statistically highly significant difference
- d = 3.20 indicates a substantial effect (Cohen's d > 0.80).

**Table 2.** Paired-Samples t-test in the Control Group

Variable	N	M (Mean)	SD	t(21)	p	d (Cohen's d)
Pretest	22	40.50	9.10			
Posttest	22	43.20	8.75	1.25	.225	0.27

Notes:

- N = 22 (number of participants)
- p = .225 → not statistically significant (p > .05)
- d = 0.27 → small effect (Cohen's d < 0.50).

**Table 3.** Independent-Samples t-test Result for Posttest Score

Group	N	M (Mean)	SD	t(42)	p	d (Cohen's d)
Experimental	22	80.00	7.20			
Control	22	43.20	8.75	10.48	< .001	3.19

Notes:

- N = 22 per group (total of 44 participants)
- p < .001 → indicates a highly significant statistical difference between the two groups
- d = 3.19 → indicates a huge effect size (Cohen's d > 0.80).

The descriptive statistics revealed a significant improvement in the speaking skills of the experimental group students. The average Pre-Test score was 39.00, with a minimum of 17.00 and a maximum of 67.00, indicating that the students initially demonstrated low oral proficiency in Speech Act requests (and generally). The mean post-test score of the experimental group following digital cognitive mapping was 80.00. The minimum posttest score increased to 50.00, and only one student (out of 22 students) did not get the highest score (100.00). The cumulative average gain of 41 points is approximately 105% of the original average. On the other hand, the control group, which had learned speaking through traditional teaching methods without cognitive and digital mapping tools, also only slightly increased their speech scores. Despite an increase from pretest to posttest (the mean score post was 43.20), it was significantly lower compared with the experimental group, in which fewer participants reached higher score areas. Although the magnitude of improvement in the experimental group may appear exceptionally large, several contextual and methodological considerations help explain why such a substantial gain was observed. First, the pretest results indicated that students initially possessed very low speaking proficiency, suggesting a considerable amount of "room for growth." Second, unlike traditional instruction, the digital cognitive mapping intervention provided continuous cognitive scaffolding during planning, rehearsal, and delivery, which may have accelerated improvement far more substantially than conventional classroom practices typically allow. Third, the speaking tasks employed in both the pretest and posttest represented comparable levels of linguistic and cognitive complexity, indicating that the dramatic improvement was unlikely to stem from task simplicity. In addition, the scoring rubric applied in this study followed widely accepted analytic speaking assessment standards covering fluency, accuracy, vocabulary, pronunciation, and discourse organization and had been reviewed for content validity by expert raters, thereby reducing the likelihood that the improvement resulted merely from instrument sensitivity. Taken together, these considerations suggest that the gain is attributable to a meaningful pedagogical effect produced by the systematic integration of digital cognitive mapping into speaking instruction. Nevertheless, the unusually

large percentage gain warrants cautious interpretation, and future studies are encouraged to replicate this intervention with different cohorts, longer intervention periods, and alternative assessment instruments to further validate the robustness and generalizability of these findings. Importantly, the statistical robustness of the improvement is also reinforced by the very large effect size (Cohen's  $d = 3.20$ ), indicating that the observed gain was not only statistically significant but also educationally meaningful.

These trends suggest that the cognitive mapping intervention, when implemented with ICT tools, may have contributed to students' improved speaking results. The estimates from inferential statistics further elaborate these patterns. The results of the paired-samples t-test in the experimental class indicated that the mean score on speaking posttest ( $M = 80.00$ ,  $SD = 7.20$ ; median = 79.24) was significantly greater than the mean score on the pretest ( $39.00$ ,  $SD=8.50$ ),  $t(21)=15.32$ .

## 2. Discussion

Studying learning conditions and strategies used by ELs is of direct interest to educators who are working with such students, however this area has received little attention from scholars. Mind mapping through language skilling development. It was found out that mind mapping also helps in enhancing memory, cohesion and linguistic creativity which are all relevant for producing connected speech (Berta & Mulat, 2024). Thus, the strong impact found in the current research could be explained as an interaction between visual knowledge organisation and guided speaking practice, thereby reducing cognitive load during speaking and increasing oral performance substantially. The second finding indicates that the control group experienced a slight and non-significant increase in speaking scores, who only received Troy's speaking instruction without cognitive or digital mapping strategies. This trend is also in line with systemic reviews of the role of ICT in EFL classrooms, which suggest that instructions still largely entrenched in traditional, text-based, and teacher-led approaches are not efficient for the meaningful development of speaking skills (Al Arif & Handayani, 2023). Similar results regarding the effects of educational technology on speaking instruction can be found in other studies as well, which also confirm that when autonomy or cognitive tasks are not included in task design, students' performance is usually restricted to mere reproduction of the language and not to the creation of a communicative spoken discourse (Benlaghrissi & Ouahidi, 2024). Quasi-experimental studies of educational speaking technology have also concluded that the mere addition of digital tools does not always lead to substantial increases in speaking scores; increases are most often observed when the foundational activities (which inform planning, practice, and feedback) for which they were designed take place with them (Genanew et al., 2023). Simultaneously, the literature on technology-enhanced language learning points out that new technologies efficiently maximize language development only when connected with learning strategies favoring planning and monitoring of speakers' own speech and also for reflection upon their language or consisting in a lot more than using them as mere presentation media (Li & Li, 2025). Therefore, the results of the control group in this study confirm that traditional speaking instruction, which is not well-cognitively oriented, does not lead to significant improvement in the speaking proficiency of EFL students. The third discovery reveals that the experimental group's post-test scores were significantly greater than those of the control group, with an enormous effect size indicating the effectiveness of digital cognitive mapping over the traditional approach. This finding is consistent with studies that have revealed significant effects on increasing the number of produced ideas, decreasing anxiety, and improving fluency in using digital mind maps for speaking, as students are provided with a visual tool to facilitate speaking performance. Recent meta-analyses of concept mapping in language learning also indicate that the effects of paper- and computer-based concept maps are more promising for productive and collaborative tasks, which require learners to construct and share actively meaning (Han, 2025). Studies into educational technology among EFL students speaking performance also indicate that using digital tools that have guided practice, immediate feedback and interactivity is more likely to result in higher scores on speaking performance than regular instruction (Hou & Min, 2025). Furthermore, ICT-based speaking instruction reviews posit that instructional designs integrating technology with explicit cognitive strategies (e.g., writing summaries or recastings) promote active engagement and learner independence, as well as improved oral skills. Thus, the stark difference between groups in this study is seen as compelling evidence that digital cognitive mapping truly serves as an effective pedagogical tool for expediting EFL students' speaking skill progress. Thus, what can be drawn is that the three results seem to form a coherent picture: (1) digital cognitive mapping induces a substantial increase of speaking ability in their experiment group; (2) traditional instruction without cognitive mapping are not enough to bring any meaningful positive effect and (3) the two-group comparison shows evidence for the superiority of digital-cognitive-mapped-based intervention method. In line with emerging research suggesting that mind/concept

mapping and well-planned language learning technologies can yield positive results in productive skills, such as speaking. The results of this study also endorse the idea that implementation of digital cognitive-mapping tools in teaching speaking at HE could be a successful and extremely beneficial activity in Indonesian EFL context. The present findings corroborate those of recent meta-analyses which report that concept mapping has a moderate to large positive effect on second language production, especially in productive skills including speaking and writing (Shi, 2023). Although the experiment is a classroom-based one, here findings indicate that there may be significant improvement in the speaking performance as of traditional teaching method (TTM) with digital mind mapping led by Dutch) research one cycle to another within two and half months just like the final reports from the junior-high and secondary speaking programs. Similar findings are reported in other studies investigating the use of mind-mapping tools for exam-driven speaking practice, which suggest that these visual tools assist students to group ideas and enhance speaking fluency and coherence, and reduce anxiety (Ghasemi & Mozaheb, 2021). Studies on mind mapping as an applicable strategy for EFL learners' language improvement confirm that idea mapping leads to the EFL students' progress in vocabulary, grammar, and speaking skills, which is in line with the overall score gains of this research. Besides, research has demonstrated that educational technologies for EFL speaking ability also produce meaningful gains when explicit learning strategies are combined with digital-tool-based interventions, as in our digitally cognitive mapping-based intervention (Trujillo & Román, 2024). These overlaid findings lend support to the proposition that a remarkable improvement in terms of SLMJs emerged from the experimental group, both theoretically and empirically. Although the current investigation reveals a powerful effect, other studies have shown more diverse effects based on task type, proficiency level, and the amount of instructional time; therefore, caution is warranted in generalizing these findings. Some technology-enhanced language learning (TELL) researchers also suggest that not all uses of technology will result in the enhancement of speaking, and positive effects emerged only when it was surrounded by an explicit pedagogical design and scaffolding. Therefore, the present study suggests that additional methods should be incorporated into future applications of digital cognitive mapping to investigate whether somebody can achieve synergy can be achieved among knowledge acquisition approaches to facilitate intervention. Furthermore, the majority of studies to date, similar to this one, are mainly concerned with English language learners in a foreign language learning context. The application of this approach to different languages and cultural backgrounds is an important task for further research on exploring its cross-linguistic and cross-cultural applicability. Finally, recent meta-analyses on dialog-based CALL systems indicate a potential for intelligent technology to accommodate speaking practice. Therefore, combining DCM with AI-driven or dialog-based environments is likely to be promising for the future development of agile learning. This study's primary contribution lies in its empirical investigation of digital cognitive mapping in EFL speaking instruction at the university level in Indonesia, employing a quasi-experimental design with a control group and thereby providing robust quantitative evidence of the intervention's effectiveness. Unlike most previous studies on mind/concept mapping in conjunction with reading or writing, which rarely employ explicit cognitive strategies in technology use, this study integrates digital cognitive mapping into the planning and enactment of spoken tasks. Such research addresses a gap in the field noted by recent authors for work in this area to develop beyond language technology adoption studies into how particular strategy-oriented tools, such as computerised concept mapping, can be used in language pedagogy. Furthermore, this research highlights a comprehensive examination of pre-test-post-test score differences and interrelationship between-group comparisons with explicitly reported effect sizes in its investigation, thus contributing to the literature on the extent to what digital cognitive mapping could have pedagogical implications for speaking. Although previous research on digital mind map and speaking has been conducted among small samples as classroom action-research, the present study's quasi-experimental design gives more confidence with casual inferences. Therefore, this research contributes to the field of TELL and cognitive strategy by showing that digital cognitive mapping is not only a tool for idea generation, but also an indispensable instrument in designing rich, large task-based speaking instruction in the Indonesian EFL setting. The last few years have seen a rapid uptake of digital resources in language classrooms, but there is little empirical evidence on how strategically these tools are used in complex speaking tasks. The current research contributes to the gap by showing that digital cognitive mapping provides learners with meaningful cognitive support at planning and production. Making an original contribution to the development of knowledge in language education, this study has shown that the inclusion of digital cognitive mapping in speaking instruction can lead to significantly greater improvements in students' speaking abilities than standard instruction, serving as a pedagogically sound learning-design model for use across a range of EFL contexts. These findings underline that visual digital support systems can scaffold learners' organization of ideas, enhance fluency, and reduce cognitive overload, especially when tasks require extended oral production. The results contribute to the empirical

evidence base for university and language teachers to incorporate digital CM strategies in their teaching, and add to the TELL literature advocating a marriage between technology and explicit learning activities.

In addition, this research emphasizes the importance of aligning technological tools with clear instructional goals, so that technology operates not merely as an add-on, but as a purposeful cognitive scaffold. More specifically, this study actively applies a model of digital cognitive mapping to pre-speaking planning stages, collaborative coloring activities, and technology-enabled feedback processes that are relevant across various institutional settings and scales. Such structured integration allows learners to visualize conceptual relationships, negotiate meaning collaboratively, and receive multimodal feedback that strengthens both accuracy and coherence in their speaking performance. Theoretically, it contributes to an emerging literature that situates computerized concept mapping as a central connector between cognitive strategy instruction, multimodal representation, and technology-enhanced speaking development. This study addresses these issues by examining how digital mapping can be aligned with diverse learner profiles, varying levels of mastery, and different types of tasks, thereby providing a strong foundation for further research. Finally, this study confirms the theoretical promise of DCM teaching in offering more depthful and strategic EFL speaking learning experiences.

### **2.1 Implications**

In practical terms, the results of this study suggest that lecturers and language teachers systematically integrate digital cognitive mapping into the planning and implementation of speaking tasks. They also encourage further research in more varied contexts, proficiency levels, and intervention durations to strengthen the empirical foundation for the application of this strategy.

### **2.2 Research contribution**

The study contributes to the EFL literature by providing empirical evidence that digital cognitive mapping significantly improves students' speaking proficiency compared to conventional instruction. These findings suggest that technology-enabled cognitive mapping effectively facilitates learners' planning, organization, and oral delivery, leading to significantly greater speaking gains. Methodologically, this study strengthens causal inference by using a quasi-experimental pretest-posttest control group design in the context of Indonesian higher education, which is still underrepresented in previous studies. Pedagogically, this research offers practical insights for integrating digital cognitive mapping into speech instruction as a learner-centered and technology-enhanced approach. Overall, this study extends the application of digital cognitive mapping to EFL speech pedagogy and lays the groundwork for future investigations across broader instructional contexts and durations.

### **2.3 Limitations**

The relatively small sample size, the implementation in only one study program at a single university, and the limited intervention duration constrain this study; therefore, readers should exercise caution when generalizing the findings.

### **2.4 Suggestions**

Based on the findings of this study, EFL lecturers and language teachers are encouraged to integrate digital cognitive mapping into speaking instruction to support students' planning and oral organization. Future research should involve larger samples, multiple institutions, and learners at different proficiency levels to improve the generalizability of the findings. Extending the duration of the intervention is also recommended to examine the long-term effects and retention of speaking skills, as well as to explore the application of digital cognitive mapping to other language skills and affective variables.

## **D. Conclusion**

Based on the data analysis, this study concludes that integrating digital cognitive mapping into speaking instruction significantly improves the speaking proficiency of EFL students compared to conventional instruction without cognitive mapping. The pretest posttest gain in the experimental group was enormous and substantially different from that of the control group, whereas the control group experienced only a slight, non-significant improvement. The difference in posttest scores between the two groups likewise indicates a clear advantage for the group receiving the digital cognitive mapping treatment. Thus, the research hypothesis is accepted, as the students taught with the support of digital cognitive mapping

demonstrated substantially greater gains in speaking ability than those instructed through conventional methods.

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### F. Author Contribution Statement

H conceptualised the study, designed the research framework, and supervised the overall project. AT was responsible for data collection, statistical analysis, and preparing the research instruments. AO contributed to the validation of the instruments, the literature review, and the critical revision of the manuscript. All authors discussed the results, contributed to the writing process, and approved the final manuscript.

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