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Using Mind-Mapping as a Pre-Reading Tool to Support Science Vocabulary Retention in English as a Medium of Instruction Classroom

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This study investigates the use of mind mapping as a pre-reading strategy to enhance English vocabulary retention in a Grade 2 science class taught through English in Vietnam. A quasi-experimental mixed-methods design was employed, incorporating three vocabulary assessments (pre-test, mid-test, and post-test), a student questionnaire, and semi-structured interviews. Two intact Grade 2 classes ($N \approx 60$) participated in the study: the experimental group received a mind-mapping intervention prior to each science lesson, whereas the control group followed traditional pre-reading activities. Vocabulary tests were administered at three points—before, during, and after the six-week intervention. The findings indicated that students in the experimental group demonstrated significantly better retention of science-related vocabulary than those in the control group. In addition, students exposed to mind mapping reported positive attitudes toward the use of this strategy in their learning process. The study provides practical pedagogical implications for educators implementing English-medium instruction (EMI), highlighting that a low-tech visual tool such as mind mapping can effectively scaffold science vocabulary acquisition and help mitigate language barriers in content-based lessons. By focusing on young learners in a bilingual science classroom, this research contributes to the growing body of literature on effective EMI strategies at the primary level and recommends mind mapping as an accessible and supportive technique for improving vocabulary retention in bilingual science education.

Keywords: EMI, pre-reading tool, mind-map, vocabulary retention, science, young learners

INTRODUCTION

English Medium Instruction (EMI), which involves the teaching of academic subjects in English to students whose first language is not English, is gaining attention across educational levels (Dearden, 2014; Bolton, 2024). As globalization increasingly demands competence in English, educational reforms in Vietnam have sought to position English as a medium of instruction (MOET, 2014). One of the orientation is to

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integrate English into core content instruction at schools- even at the primary level. However, the intersection between language learning and content acquisition poses particular challenges for young learners, especially in cognitively demanding subjects like science (Vu & Burns, 2014; Nguyen & Phuong, 2023). At the primary level, EMI instruction is often characterized by a dual burden: students must simultaneously decode complex subject matter and navigate a foreign language (Macaro, 2018). This duality is particularly challenging in science education, which introduces technical and abstract vocabulary that is not part of students' everyday lexicon. Without structured support, many learners struggle to retain such vocabulary, leading to surface-level comprehension and reduced academic confidence. From the observation during our teaching career, one pedagogical gap noticed in EMI science education is the lack of pre-reading strategies designed specifically for vocabulary retention. Pre-reading prepares learners to understand and engage with academic content before direct instruction occurs (Colorado, 2023). However, in many Vietnamese education, pre-reading is overlooked or limited to silent reading or teacher explanation of keywords without visual or contextual scaffolding (Nguyen & Nguyen, 2020). Despite the rise of English-medium instruction in Vietnam's primary schools, few studies have examined young learners' needs in such settings. Most EMI research focuses on older students (secondary or tertiary levels), meaning significant gaps remain in understanding how to support vocabulary acquisition for children in Grade 2. Young EMI learners often struggle with technical terms in science, facing what Macaro (2018) calls a "dual burden" of learning content and language at once. In Vietnamese primary science classes, from our teaching experiences, this challenge is exacerbated by a lack of effective pre-reading strategies for vocabulary. Traditionally, teachers may either skip pre-teaching key words or rely on translations and simple flashcards. Without richer support, students resort to rote memorization and quickly forget new terms, undermining both language and content mastery. This situation highlights an urgent need for research-based techniques to bolster vocabulary retention in young EMI learners.

From the above-mentioned situation, this study was conducted to examine if the usage of mind-mapping as a pre-reading tool can support science vocabulary in Grade 2 EMI students. The approach aligns with cognitive theories (Paivio, 1986) suggesting that combining verbal and visual information aids memory. Notably, mind mapping is low-cost and age-appropriate: it caters to young children's love for colors and pictures, and encourages active participation in learning vocabulary. Prior work hints at its benefits - for example, Al-Jarf (2009) found that mind maps enhanced EFL vocabulary acquisition, and Wu & Zheng (2023) reported improved retention and interest when using mind maps in English lessons. However, no published study to date has tested mind mapping in Vietnam's primary EMI education, leaving a research gap in both context and age group. Furthermore, existing studies rarely combine quantitative outcomes with learners' perspectives, which are crucial for a holistic understanding of any pedagogical intervention. By filling this niche, the study tried to advance both academic understanding and classroom practice, ultimately fostering more equitable and successful EMI outcomes for young learners. To come to this end, the study sought to answer the two following questions:

1. How does the use of mind-mapping as a pre-reading tool influence science vocabulary retention in primary EMI students?

2. What are students' perceptions of using mind-mapping in pre-reading activities to support their acquisition of science vocabulary in EMI education?

Literature Review

English Medium Instruction (EMI) is defined as the use of the English language to teach academic subjects (other than English itself) in countries or environments where English is not the first language of most of the population (Macaro, 2018, p. 1). In an EMI classroom, English is the vehicle of instruction for subjects like science, mathematics, or history, even though the students' native language is something else (Macaro et al., 2018). EMI has been increasingly adopted around the world, especially in Asia, as part of educational internationalization efforts (Gilanyi et al., 2023). The rationale is that by learning content through English, students will simultaneously develop their English proficiency and subject knowledge. However, EMI also presents unique challenges, particularly at the primary and secondary school levels where students are still developing basic language skills in their mother tongue and in English (Benson, 2008; Mwinsheikhe, 2009). The literature reveals a predominance of transmission-oriented pedagogy in EMI classrooms, where lecturers often rely on monologic teaching methods (Bolton et al., 2024). This approach limits to some extent students' engagement and interaction, as many students hesitate to participate actively in discussions due to language barriers and cultural factors (Kirkpatrick, 2017). The current situation in EMI classes reflects a complex interplay of challenges related to language proficiency, pedagogical practices, and the need for targeted teacher training (Vu & Burn, 2014). Addressing these issues is crucial for improving the quality of education in EMI settings.

One of the most significant challenges in English-medium instruction (EMI) is learners' limited mastery of academic and subject-specific vocabulary. While young learners often acquire basic interpersonal communication skills relatively quickly, they frequently struggle with the vocabulary needed to understand and discuss academic concepts (Kirkpatrick, 2017; Owu-Ewie & Eshun, 2015; Truong, 2021; Sukmawati & Pujiani, 2024). For example, students may understand everyday words such as *water* but find it difficult to grasp more abstract scientific terms such as *natural resources* or *water conservation*. Because these concepts are often unfamiliar and cognitively demanding, learners may rely on memorization or first-language translations rather than developing a deeper conceptual understanding (Bernardo, 2000). Research has consistently identified academic vocabulary as a major barrier to content comprehension in EMI settings (Othman, 2024; Owu-Ewie & Eshun, 2025). This challenge is further intensified when teachers lack adequate training in integrating language and content instruction, leading them to spend considerable class time explaining terminology, simplifying content, or code-switching to students' first language (Do & Le, 2022; Nguyen & Nguyen, 2020).

To address these challenges, researchers have emphasized the importance of explicit and systematic vocabulary support in EMI classrooms. Pre-teaching key vocabulary

before introducing new content has been shown to enhance learners' comprehension and facilitate content learning (Pellicer-Sánchez et al., 2020). In addition, multimodal instructional approaches that combine verbal explanations with visual representations can improve vocabulary retention and reduce cognitive load (Li et al., 2022). Among these approaches, mind mapping has emerged as a promising strategy because it helps learners visually organize vocabulary, identify relationships among concepts, and actively construct meaning. By providing structured and meaningful vocabulary support, such strategies can help learners overcome language barriers and engage more effectively with academic content in EMI contexts.

Another concern is that EMI textbooks and curricula may not sufficiently support vocabulary development. In Vietnam's primary EMI program, for instance, the Grade 2 science textbook (e.g., Happy Science 2) introduces new vocabulary each unit and includes basic exercises such as matching words to pictures or filling in blanks. While these activities help with initial familiarization, they offer limited practice in using the new words in context or connecting them across units. There is usually no built-in review of vocabulary from previous units, meaning words learned in one lesson might not reappear later, leading to fragmented learning. Students might study "weather" words in one unit (sunny, rainy, windy, etc.) and "animal" words in another, but never be guided to see relationships (for example, how weather affects animals, or how some words can be used in multiple contexts). Such fragmentation can impede vocabulary retention and depth of knowledge. As a result, students often memorize terminology for a test and then quickly forget it, since they haven't integrated it into a broader schema.

A challenge in EMI is the monolingual policy, which often requires teachers and students to use only English, sometimes discouraging engagement if students don't understand. While the intent is to maximize English exposure, modern perspectives advocate a flexible, bilingual approach in young learner education (Apilicueta-Martinez, 2025). In Vietnam, however, there is inconsistency on when Vietnamese can be used. Nguyen et al. (2023) found that students valued explanations in Vietnamese for difficult concepts, suggesting a balanced approach is needed. Teachers in primary settings often switch to Vietnamese instinctively, but this is not always systematically planned.

Our study addresses vocabulary challenges in EMI by introducing a mind-mapping pre-reading strategy. For young EMI learners, the mind-map technique is particularly effective. Feng et al. (2023) found that elementary EFL learners using mind maps showed significantly better vocabulary recall and retention compared to a traditional method group. Similarly, Shdaifat et al., (2019) showed that electronic mind mapping improved vocabulary mastery for Jordanian middle-school students, with students highlighting the benefit of "seeing connections". Hasibuan (2022) also found that mind-mapping enhanced reading comprehension for Indonesian 8th graders, helping them identify main ideas and supporting details. Integrating pre-reading activities into EMI and bilingual education not only facilitates comprehension but also cultivates learners' metacognitive awareness, fostering more strategic and autonomous reading habits (Li et al., 2024). Tools such as the Metacognitive Awareness of Reading Strategies Inventory (MARSI) (Mokhtari et al., 2018) have shown that even novice readers can develop

awareness of strategies like previewing texts and self-questioning before reading. To this extent, mind maps may also promote metacognition.

Finally, this study situates itself within the broader context of EMI research in Vietnam, where few studies have focused on primary school-level EMI. Truong (2021) is a key work that surveyed primary teachers about their perceptions of EMI. While teachers recognized the benefits of exposing students to English early, they highlighted concerns like a lack of age-appropriate materials, inadequate training, and challenges in ensuring comprehension.

In summary, despite the increasing popularity of English-medium instruction (EMI) and content-based language learning, important gaps remain in the literature. First, EMI research has largely focused on secondary and tertiary education, while the needs of young learners in primary schools have received limited attention (Gilanyi et al., 2023). Grade 2 learners differ substantially from older students in their cognitive, linguistic, and learning characteristics, requiring age-appropriate, engaging, and scaffolded instructional approaches. This study addresses this gap by investigating the use of mind mapping as a pre-reading strategy in a Vietnamese primary EMI context, thereby contributing empirical evidence on both learning outcomes and student attitudes. Second, vocabulary learning in many EMI classrooms remains fragmented, with limited opportunities for reinforcement across topics. Drawing on research highlighting the importance of repeated exposure and meaningful connections among words (Nation, 2022), this study demonstrates how cumulative mind maps can promote thematic links and vocabulary retention, offering a practical solution to the common challenge of isolated vocabulary instruction in content-based classes. Third, much of the existing research has relied predominantly on either quantitative or qualitative approaches. While these studies have provided valuable insights, the use of a single methodological approach may limit the comprehensiveness of the findings. To address this limitation, the present study adopted a mixed-methods design, integrating both quantitative and qualitative data. This approach enabled a more nuanced understanding of the research phenomenon by allowing the findings from one method to complement and enrich those from the other. In short, this study aims to fill the above gaps by providing evidence on a specific strategy that supports vocabulary retention and comprehension in primary EMI science classes. It offers a novel integration of mind-mapping into early EMI instruction, measuring both linguistic and attitudinal outcomes.

METHOD

Research design

This study employed a quasi-experimental mixed-methods design to examine the impact of a mind-mapping pre-reading intervention on science vocabulary acquisition. Two intact Grade 2 classes served as the experimental and control groups. Quantitative data were collected through vocabulary tests administered at three points (pre-, mid-, and post-test) to measure students' vocabulary development over the six-week intervention. Qualitative data were gathered through a student questionnaire and interviews with the teacher and selected students to explore participants' perceptions of the intervention and their classroom experiences. The quantitative and qualitative

components were designed to complement each other: while the test results provided evidence of vocabulary learning gains, the questionnaire and interview data helped explain how students experienced the intervention and the factors that may have contributed to the observed outcomes. The two datasets were analyzed separately and then integrated during the interpretation stage to provide a more comprehensive understanding of the effectiveness of mind mapping in the EMI classroom.

Participants

The participants were two intact Grade 2 classes (N = 60) from a Vietnamese primary school implementing an English-medium instruction (EMI) program. The students, aged 7–8 and native Vietnamese speakers, had approximately two years of EMI experience. Prior to the intervention, the school records indicated that both classes had followed the same EMI curriculum and achieved comparable academic performance in science and English during the previous semester. Both classes were taught by the same bilingual teacher and followed identical instructional content, learning objectives, and assessment procedures throughout the study to ensure instructional consistency. Class 2A served as the experimental group using mind-mapping activities, while Class 2B functioned as the control group receiving traditional pre-reading instruction. Written parental consent was obtained for all participants. The use of intact classes preserved the natural classroom setting while maintaining comparable learning conditions for examining the effects of mind mapping on science vocabulary acquisition.

Research Instruments

Vocabulary Tests

Three equivalent vocabulary tests (pre-test, mid-test, and post-test) were developed to assess students' science vocabulary during the intervention. The tests were aligned with the Grade 2 science curriculum and included visually supported tasks suitable for young learners. Activities involved picture–word recognition, matching or multiple-choice items, and gap-filling sentences using a word bank. Instructions were explained by the teacher, and students responded by writing, circling, or drawing lines. A consistent 10-point scoring scale was applied across all tests. To ensure validity and reliability, the tests were reviewed by two English education lecturers and piloted with another Grade 2 class, producing a KR-20 reliability coefficient of 0.76.

Student Perception Questionnaire

A questionnaire was designed to complement the test results by collecting Grade 2 students' feedback on learning science vocabulary and using mind mapping. To suit young learners, the instrument used a simple Yes/No format with short, positively worded statements. It examined four aspects: enjoyment of learning English vocabulary, engagement in mind-mapping activities, perceived usefulness of mind maps for remembering words, and confidence in learning science through English. The questionnaire was reviewed by experts and piloted with five students, resulting in a final set of 10 items. It was administered anonymously to the experimental group after the intervention, and the results showed high reliability based on Cronbach's alpha of 0.82.

Interviews

Two semi-structured interviews were conducted to obtain qualitative insights: an individual interview with the Grade 2 science teacher and a focus group with five students from the experimental class. The teacher interview explored student engagement, differences between the two classes, the effectiveness of mind maps for vocabulary learning, implementation challenges, and potential future use. The student focus group included age-appropriate questions about their experiences and feelings toward mind mapping. Both sessions were conducted in Vietnamese, audio-recorded with consent, and later transcribed and translated for thematic analysis. Identities were anonymized, and the qualitative data complemented the quantitative findings, enhancing the study's validity through methodological triangulation.

Procedure

The study was conducted over six weeks and followed three main phases: preparation, intervention, and post-intervention evaluation. In Week 1, both classes completed a pre-test measuring their baseline knowledge of target science vocabulary. Prior to the test, Class 2A received a brief introduction to mind maps, while Class 2B followed regular instruction without this strategy.

During Weeks 2–5, the intervention was implemented while teaching Units 4–6 in English. Each unit introduced approximately 8–10 target science vocabulary items, resulting in a total of 27 vocabulary items across the three units. In Class 2A, students created colorful teacher-guided mind maps during the pre-reading stage to organize and connect key vocabulary and concepts. The mind maps were designed with a central topic placed in the middle of the page and several main branches representing key concepts, with sub-branches containing target vocabulary, simple definitions, pictures, and examples. Students collaboratively contributed ideas while the teacher facilitated the construction of the mind maps and encouraged discussion of relationships among concepts. In contrast, Class 2B learned the same vocabulary through traditional pre-reading instruction, including teacher explanations, repetition drills, and textbook-based vocabulary exercises. Both groups received the same instructional content and amount of teaching time. A mid-test in Week 3 assessed students' progress after the first phase of the intervention.

In Week 6, both classes completed a post-test covering all target vocabulary. In addition, Class 2A completed a Yes/No questionnaire, and interviews were conducted with the teacher and five students to explore perceptions of mind mapping. Overall, the structured procedure ensured consistent teaching conditions, allowing the effect of mind mapping on vocabulary learning to be examined.

Data Analysis

Data were analyzed using a mixed-methods approach combining quantitative and qualitative techniques. Vocabulary test scores were processed in SPSS using descriptive statistics, independent t-tests. Results showed significantly greater gains for the mind-mapping group ($t(58) = 3.92$, $p = .001$; Cohen's $d \approx 1.0$), confirming a strong

intervention effect. Questionnaire responses were analyzed descriptively and indicated highly positive attitudes toward mind mapping, with 93% agreement on key items and good reliability (Cronbach's α = 0.82). Interview data were thematically analyzed, revealing themes such as increased engagement, improved recall, and effective teacher scaffolding. Students' and the teacher's comments highlighted the role of visualization in supporting learning and motivation. To ensure scoring reliability, the researcher marked all tests while blinded to group identity, and a second rater cross-checked 20% of the scripts (r = .95).

FINDINGS

Effect of Mind Mapping on Science Vocabulary Acquisision

To address the first research question, vocabulary test scores from the treatment group (Class 2A, using mind mapping) and the control group (Class 2B, traditional method) were collected at three time points: a pre-test (before the intervention), a mid-test (halfway through), and a post-test (after the intervention). Table 1 presents the descriptive statistics for each group at each testing stage.

Table 1
Descriptive statistics for vocabulary test scores by group and testing time

Test Time	Group	N	Mean	SD
Pre-test (Week 0)	Experimental (2A)	30	8.50	0.94
	Control (2B)	30	8.48	0.95
Mid-test (Week 3)	Experimental (2A)	30	9.00	0.83
	Control (2B)	30	8.51	0.83
Post-test (Week 6)	Experimental (2A)	30	9.50	0.76
	Control (2B)	30	8.73	0.77

The table presents the descriptive statistics for the reading test scores of the experimental group (2A) and the control group (2B) across three testing occasions: pre-test (Week 0), mid-test (Week 3), and post-test (Week 6), in relation to the use of mind maps during the pre-reading stage.

At the pre-test stage, both groups demonstrated nearly identical performance. The experimental group obtained a mean score of 8.50 (SD = 0.94), while the control group achieved a very similar mean score of 8.48 (SD = 0.95). This similarity suggests that the two groups started with comparable reading proficiency before the intervention was implemented. By the mid-test in Week 3, a slight improvement was observed in the experimental group, with the mean score increasing to 9.00 (SD = 0.83). In contrast, the control group showed almost no change, with a mean score of 8.51 (SD = 0.83). This difference indicates that students exposed to mind mapping in the pre-reading stage began to demonstrate better reading performance than those in the control group. The difference became more pronounced in the post-test (Week 6). The experimental group's mean score further increased to 9.50 (SD = 0.76), whereas the control group achieved a mean score of 8.73 (SD = 0.77). Although both groups showed some improvement over time, the experimental group exhibited a greater increase in performance. Overall, the results suggest that the use of mind maps in the pre-reading

stage may contribute positively to students' reading comprehension and learning outcomes.

Independent-samples t-tests were conducted to compare the two groups' performance at each stage. The results of these tests (t, degrees of freedom, p-value) are summarized in Table 2. These analyses determine whether any observed differences in mean scores between the experimental and control classes were statistically significant.

Table 2
Independent samples t-test results

Comparison	t (df = 58)	p (2-tailed)	Significance
Experimental vs. Control - Pre-test	0.07	.946	n.s. (no sig. diff.)
Experimental vs. Control - Mid-test	2.30	.029	p <.05 (significant)
Experimental vs. Control - Post-test	3.92	.001	p <.01 (highly significant)

The table 2 presents the results of the independent samples t-tests comparing the performance of the experimental group and the control group at three different testing times.

At the pre-test stage, the difference between the experimental group and the control group was not statistically significant ($t(58) = 0.07$, $p = .946$). This result indicates that the two groups had almost identical levels of reading performance before the intervention, confirming that the groups were comparable at the beginning of the study.

In the mid-test (Week 3), a statistically significant difference emerged between the two groups ($t(58) = 2.30$, $p = .029$, $p < .05$). The experimental group, which was taught using mind maps in the pre-reading stage, performed significantly better than the control group. This finding suggests that the use of mind mapping began to have a positive effect on students' reading comprehension after several weeks of implementation.

By the post-test (Week 6), the difference between the two groups became even more pronounced. The results showed a highly significant difference ($t(58) = 3.92$, $p = .001$, $p < .01$), indicating that the experimental group significantly outperformed the control group. This result provides strong evidence that the integration of mind maps in the pre-reading stage can substantially enhance students' reading comprehension over time.

In summary, the data clearly show that mind mapping significantly enhanced students' vocabulary acquisition in an EMI science context. While both groups began at the same level, Class 2A demonstrated superior progress at both mid-point and post-test stages, with statistical significance achieved at each.

Students' Perceptions of Using Mind Mapping

To answer the second research question, a student perception questionnaire was administered to the experimental group (Class 2A) after the intervention. The questionnaire consisted of 10 Yes/No items, designed to gauge students' attitudes, interest, and engagement regarding the mind mapping activities in learning science vocabulary. Table 3 summarizes the results of student responses.

Table 3
Distribution of students' responses to the perception questionnaire (N = 30)

Questionnaire Item	*Yes (n, %)*	*No (n, %)*
I like learning science in English.	28 (93.3)	2 (6.7)
I like learning new English words in science class.	27 (90.0)	3 (10.0)
I like using mind maps in my science lessons.	29 (96.7)	1 (3.3)
Mind maps make it easier to learn new words.	27 (90.0)	3 (10.0)
Mind maps help me remember new words.	28 (93.3)	2 (6.7)
Mind maps help me understand my science lessons.	26 (86.7)	4 (13.3)
I learn new words faster when I use mind maps.	22 (73.3)	8 (26.7)
I feel happy when I use a new English word in class.	27 (90.0)	3 (10.0)
I want to use mind maps to learn new words in the future.	28 (93.3)	2 (6.7)
It is important to learn new English words.	30 (100)	0 (0.0)

The questionnaire results show highly positive student attitudes toward learning science vocabulary and using mind maps. Most students enjoyed learning science in English (93.3%) and learning new words (90%). A large majority reported that mind maps helped them learn, remember, and understand vocabulary. Although fewer students felt mind maps helped them learn faster (73.3%), overall perceptions remained positive. Most students also expressed happiness when using new English words and a willingness to continue using mind maps.

Despite the overwhelmingly positive feedback, a few minor challenges were hinted at by the questionnaire results and classroom observations. A small subset of students (approximately 20%, or 6 out of 30) indicated "No" to the statement "*I can make a mind map by myself easily"*. In other words, while most students felt confident, a few found it difficult to create mind maps on their own. This is not surprising given the age of the learners - second graders are still developing fine motor skills and need guidance in organizing information. Some children might have been unsure how to start a mind map without the teacher's help, or they might have felt their drawing abilities were limited. This underscores the importance of scaffolding, such as providing templates or modeling, to help younger learners gain autonomy. Similar challenges were noted by Duong (2020), who found that even older students struggled to select key concepts and design creative maps. In this study, struggling students likely found it hard to identify salient vocabulary or worried about producing a "correct" map. Such initial difficulties are common and can be mitigated through structured practice and support.

The open-ended feedback obtained from both the questionnaire and the student interviews provided nuanced, illustrative evidence supporting the quantitative attitudinal findings. Many students expressed genuine enthusiasm for the mind-mapping activities. One student in Class 2A enthusiastically remarked, "Teacher, I find using mind maps very enjoyable; we can be creative and remember vocabulary faster. Another student indicated anticipation for English lessons involving mind maps, stating, "Creating the mind maps makes the lesson interesting, and later I can explain it to my friends and still remember the words". Such statements suggest that mind mapping not only facilitated vocabulary retention but also encouraged students to actively use the newly learned words-such as by reconstructing the map or explaining it to peers-thereby reinforcing their learning. Several students also highlighted specific aspects of the

activity that aided memory, including the use of colors, drawings, and the collaborative nature of constructing the mind maps.

The English teacher of Class 2A corroborated these perceptions by noting observable improvements in student engagement throughout the intervention. In her interview, she reflected: "The mind-mapping sessions kept the students highly engaged and eager to participate. Even the more reserved students contributed, recalling vocabulary from the map and attempting to use it in their answers" (Teacher. 4). She further explained that presenting vocabulary within an organized, visual context helped students internalize and apply the words more effectively during lessons. Another teacher concluded that mind mapping markedly enhanced student motivation and participation:

> *"Compared to the usual drills, the mind maps made a significant difference - the students paid close attention, enjoyed the creative aspects, and learned without feeling pressured. In subsequent lessons, they could still recall many of the words from the earlier maps. It proved to be a highly effective strategy."(Teacher 3.)*

Overall, students' attitudes toward mind mapping were highly positive, with nearly all in Class 2A expressing enthusiasm and even interest in applying the technique to other subjects. This suggests mind mapping effectively made science vocabulary acquisition more engaging and child-friendly by incorporating visual and kinesthetic elements, reducing the monotony of rote memorization. Students' enjoyment and perceived usefulness align with findings by Feng et al. (2023), who reported increased motivation among young EFL learners using mind maps. While some initially required guidance to create maps independently, these challenges are typical and addressable through scaffolding.

DISCUSSION

These results bear several implications and points of interpretation, especially when viewed in light of prior research and theories on vocabulary acquisition and EMI education. First, the significant vocabulary gains observed in the mind-mapping class support the idea that active, visual learning techniques can improve subject vocabulary retention in young learners. The multi-modal exposure likely contributed to the better performance of the experimental group, as it resonates with Nation's (2001) principle that rich and repeated encounters with words are critical for moving them into long-term memory. Although our study did not explicitly measure long-term retention beyond the post-test, the immediate post-test results suggest that mind mapping can facilitate the deep processing that promotes retention (Nation & Webb, 2021). Indeed, the mind map group's ability to recall nearly all the target words by the end (average 9.5/10 correct) indicates that many students had effectively internalized the vocabulary, not just recognized it. The finding is in line with Wu and Zheng (2023) and Al-Jarf (2009). Our study extends these positive findings into a primary education and content-based learning context, demonstrating that even 7-8 year-olds in a science class can benefit from and enjoy mind mapping. In this sense, the strategy contributes not only to vocabulary development but also to addressing a central concern in EMI pedagogy: enabling learners to engage more successfully with academic content through English.

Therefore, mind mapping may represent a useful instructional tool for supporting language and content learning in primary EMI classrooms.

In our study, mind mapping seems to have functioned as a form of cognitive scaffolding that mitigated the learning overload. By front-loading the key vocabulary with visual support and connections, the mind maps likely reduced the in-class processing burden on students. The finding is in line with Othman (2024), who emphasized that providing scaffolds for technical terms can prevent cognitive overload and improve content learning. This suggests that mind mapping helped free up cognitive resources for understanding science content by preemptively addressing vocabulary grasp, which in turn presumably eased content comprehension (though we did not measure content comprehension directly, the teacher perceived a difference in how smoothly lessons ran). These findings suggest that vocabulary-focused scaffolding may help address a common challenge in EMI classrooms by making subject content more accessible to young learners.

Another important aspect of the findings is the affective dimension - students' motivation and attitude. The enthusiastic student responses we recorded are consistent with Feng et al. (2023), who in a recent study noted that learners who used mind-mapping techniques showed higher motivation and engagement than those who didn't. The convergence of our results with such studies lends credibility to the effectiveness of mind mapping to be a versatile tool across ages and contexts for vocabulary acquisition. The high levels of enjoyment reported are not trivial; they matter because young learners who find an activity fun are more likely to pay attention, put in effort, and persist when encountering difficulties. The fact that 100% of the experimental students liked using mind maps is a strong endorsement. This enthusiastic reception likely created a virtuous cycle: students enjoyed the mind maps, which led them to engage more deeply with the vocabulary, which then led to better learning, reinforcing their positive attitude. This interpretation aligns with self-determination theory and other educational psychology frameworks that link intrinsic motivation to improved learning outcomes. It also aligns with practical observations by Pinter (2006) and others that visual and game-like activities increase young learners' engagement. In the context of EMI, where students might otherwise feel anxious or alienated by the use of a foreign language, an enjoyable activity can lower their affective filter and encourage more active participation. The teacher interview highlighted this transformation, noting that some typically shy students became much more animated and willing to share during the mind map sessions - an indication that the intervention helped build confidence. This resonates with findings from Truong (2021), who reported that Vietnamese primary EMI teachers felt a key challenge was keeping students confident and motivated in English; strategies that inject fun and visual learning can be a remedy to this challenge.

In conclusion, the findings strengthen the argument that mind mapping can serve as a powerful pedagogical tool in young learner education, particularly in contexts like EMI where vocabulary support is crucial. They also echo and extend findings from prior research, reinforcing that our study is not an outlier but part of a growing evidence base that graphic organizers (like mind maps, concept maps, etc.) are effective for

vocabulary and content learning (Nesbit & Adesope, 2006; Elshazly, 2019). What this study adds is a focused look at Grade 2 EMI science - a context that had little data before - thereby contributing new insights to both EMI literature and vocabulary pedagogy.

CONCLUSION

This study contributes to the growing body of research on English-medium instruction at the primary school level by demonstrating the potential value of mind mapping as a vocabulary-support strategy in content-based learning. Rather than merely serving as a vocabulary-learning tool, mind mapping appears to offer a form of pedagogical scaffolding that can help young learners navigate the linguistic demands of learning subject content through English. In EMI classrooms, where students are required to simultaneously process new concepts and a foreign language, visual and interactive strategies such as mind mapping may help make content more accessible and reduce barriers to participation. The findings therefore highlight the importance of integrating language-support mechanisms into EMI instruction, particularly for younger learners who are still developing both academic language and subject knowledge. In addition, this study also underscores the need for age-appropriate pedagogical approaches in primary EMI settings, an area that remains underrepresented in the literature. Given the increasing implementation of EMI programs worldwide, teachers and curriculum designers may benefit from incorporating structured vocabulary scaffolding activities that explicitly connect language learning with content learning.

Several avenues for future research emerge from this study. First, longitudinal studies are needed to examine whether the benefits of mind mapping are sustained over longer periods and contribute to long-term vocabulary retention. Second, future research could investigate the effects of mind mapping on broader learning outcomes, such as content comprehension, academic language development, and classroom interaction in EMI contexts. Third, studies involving larger and more diverse samples across different grade levels, subjects, and educational settings would help establish the generalizability of the findings. Finally, comparative research exploring mind mapping alongside other vocabulary-support and scaffolding strategies could provide further insights into effective pedagogical practices for supporting young learners in EMI classrooms.

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