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Enhancing English comprehension: a UbD mind walker intervention for remote upper-grade elementary students

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Abstract

This preliminary study examines the efficacy of the Mind Walker Reading Programme in improving word knowledge and, consequently, improving reading comprehension skills for three upper-grade elementary students in a remote setting. The programme is based on the understanding by design (UbD) Model developed by Wiggins and McTighe (The understanding by design guide to creating high-quality units, ASCD, Alexandria, 2011; The understanding by design guide to advanced concepts in creating and reviewing units. ASCD, Alexandra, 2012), emphasizing defined reading comprehension outcomes and appropriate indicators for assessment. To assess the Programme's impact and the retention of acquired skills, pre- and post-tests were administered, with a delayed post-test conducted over an 11-week period. Analysis of the test results, collected from the city government's test pool, reveals a significant improvement in reading comprehension accuracy among participants using the UbD Mind Walker reading tool. This study highlights the effectiveness of the UbD Mind Walker programme in enhancing English language proficiency and supporting sustainable learning for elementary school students, particularly in remote areas with limited educational resources.

Keywords: Understanding by design (UbD), Mind mapping, Word knowledge, Reading comprehension, Sustainable learning

Introduction

In remote areas of Taiwan, students face obstacles in accessing crucial elements of language acquisition, such as English learning opportunities, peer interaction, and collaborative learning—resources readily available in urban settings. This discrepancy is notably manifested in the scarcity of qualified English teachers, language learning centres, and intercultural resources, limiting students' exposure to the English language. In the targeted research area, the primary challenge in English reading revolves around the pervasive issue of inadequate reading comprehension skills. This deficiency may result in difficulties extracting key details, understanding written information, having limited access to knowledge, experiencing reduced academic performance, and encountering obstacles in future communication abilities. Therefore,

the current research strives to develop a practical reading formula tailored for teachers in remote areas or working with slow learners. Despite the variation in teachers every semester, the learning process remains consistent, allowing students to maintain a steady learning pace for reading comprehension.

Various theoretical models elucidate the intricacies of reading comprehension by delineating cognitive and linguistic processes. Different reading models in education and psychology have utilised the cross-lagged panel correlation procedure over the years like the construction-integration model (Kintsch & VanDijk, 1978; Wharton & Kintsch, 1991), the causal network model (Trabasso et al., 1989), the structure-building model (Gernsbacher, 1990), the resonance model (Albrecht & O'Brien, 1993; Myers & O'Brien, 1998), the constructionist model (Graesser et al., 1994), the event-indexing model (Zwaan et al., 1995), the memory-based text-processing models (McKoon et al., 1996; O'Brien et al., 1998), and the landscape model (Tzeng et al., 2005). All of which represent process-based models aiming to identify the mental representation formed during the understanding of words, sentences, and relationships in a text.

Gough and Tunmer (1986) developed the Simple View of Reading (SVR) model, which concentrates on the developmental pathways of processes and skills essential for comprehension. This model has also influenced contemporary reading models including the path model (Mellard et al., 2010), the metacognitive knowledge model (Muijselaar et al., 2017), and the direct and inferential mediation model (Härtig et al., 2022). Despite their differences, all theoretical models concur that reading comprehension fundamentally involves constructing a coherent mental representation of the text in the reader's memory. The present research extends the SVR model with a backward design approach to decoding words and their meaningful usage. To tackle this concern, a Mind Walker Reading Programme is developed based on the Understanding by Design Model (UbD) by Wiggins and McTighe (2011, 2012). The hypothesis suggests that by prioritising the enhancement of reading comprehension skills and concurrently revisiting and reinforcing participants' word knowledge, there will be a cultivation of improved reading comprehension abilities. A robust understanding and application of word knowledge are anticipated to enhance readers' comprehension across phrases, sentences, short passages, and long texts (see Fig. 1).
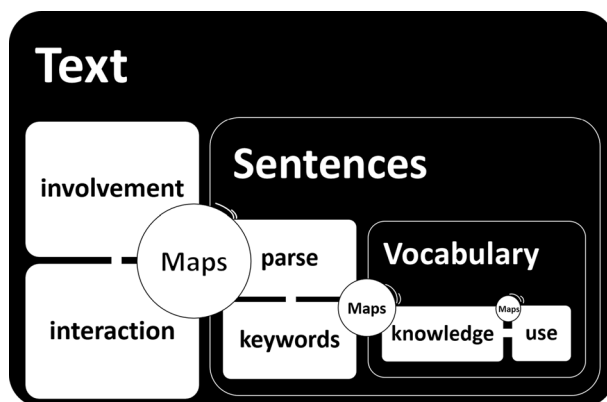

Fig. 1 UbD reading comprehension model

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Based on mind mapping theory, the programme is designed to enhance participants' desired learning outcomes, specifically concentrating on improving their reading skills through vocabulary extension with the aid of mind maps. The backward design approach encompasses refining word knowledge and usage, enhancing comprehension of connected phrases and keywords in sentences and paragraphs, and promoting the effective application of reading strategies. As participants progress, the goal is for them to fully comprehend a text, thereby achieving their desired learning outcomes. This involves employing various strategies, including activating prior knowledge, establishing word and phrase connections, posing questions, predicting context, summarising, and monitoring comprehension—all aligned with the backward design framework.

Literature review

Meaningful learning with conceptual organisers

Research consistently shows that learners benefit from constructing understanding and connecting new information to existing knowledge and experiences (Bryce & Blown, 2023; Demetriou et al., 2022; Guo et al., 2023; Hattan et al., 2023; Liu et al., 2023) since Ausubel (1968) formalised the perspective that individuals acquire new ideas by building upon existing knowledge. Expressed in his statement, "The most important factor influencing learning is what the learner already knows. Ascertain this and teach accordingly" (Preface, p. vi), Ausubel laid the foundation for his initial investigation, indicating that students derive significant benefits by integrating new concepts and thinking modes with their existing knowledge, thereby fostering meaningful learning. Novak (2010) expanded Ausubel's concept, suggesting that meaningful learning involves assimilating new concepts and propositions into existing cognitive structures.

Furthermore, Novak and Cañas (2006) demonstrated the utility of cognitive maps in combining ideas, minimising misunderstandings, and reducing cognitive load. It serves as a creative learning strategy, aiding in the logical synthesis, organisation, and placement of concepts within a conceptual hierarchy to enrich learning efficacy (Aguiar & Correia, 2017; Clayton, 2006; Farrokhnia et al., 2019; Gurlitt & Renkl, 2010; Haugwitz et al., 2010; Roessger et al., 2018). Barta et al.'s (2022) meta-analysis suggests that concept mapping is more effective than traditional teaching in improving critical thinking and disposition outcomes. Hattie and Yates (2014) also affirmed the effectiveness of visual concept organisation in enhancing learning outcomes, recommending its full integration into instructional design. Engaging students in sorting data and using techniques like concept maps fosters a comprehensive understanding by connecting new information with existing knowledge structures.

Visual learning and knowledge retention

In delving into memory-related literature, Oxford (1990) focuses on language learning and explores ten sub-memory strategies intricately connected with her approach. These strategies, including grouping, associating/elaborating, contextualising, using imagery, semantic mapping, keywords, sound representation, structured reviewing, physical response or sensation, and mechanical techniques, are recognised as valuable contributors to enhancing long-term memory in language learners. Concurrently, Zlotnik and Vansintjan (2019) detail the five stages of memory—encoding, storage, recall, retrieval,

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and forgetting—emphasising the impact of various factors on each stage. They under-score the significance of visual imagery in encoding and the role of retrieval cues. Both sources converge on the importance of memory strategies, asserting that individuals, through their use and understanding of memory stages, can improve their ability to recall information and facilitate long-term retention.

Vogel et al. (2005) discovered that the brain processes images 60,000 times faster than text, highlighting the crucial role of visual communication, which constitutes 75% of all processed information in the human brain. Vanichvasin's (2021) study indicates that dia-grams, charts, and images enhance university students' retention and recall of informa-tion compared to traditional learning methods, emphasising the significance of visuals. Moreover, 90% of the information transmitted to the brain is visual, underscoring the powerful impact of visuals in processing sensory information (Potter et al., 2014). For English language learners, memory is vital in vocabulary acquisition and reading com-prehension. Zahedi and Abdi () demonstrated that the imagery strategy positively affects vocabulary acquisition for EFL learners, resulting in higher motivation and engagement than in traditional vocabulary learning groups. Hernández-Chérrez and Moya (2018) advocate for the use of visual aids such as pictures, videos, and graphic organisers in EFL instruction, asserting that they assist and enhance students' language learning, leading to improved academic performance.

Mind mapping and reading comprehension

Integrating word knowledge theories with mind mapping in education fosters both receptive and productive word knowledge, enhancing comprehension and overall learning. This synergistic approach, as demonstrated by Cahyani et al. (2015) and Saori (2020), improves language understanding, retention, and motivates students in read-ing classes. Alongside word knowledge, mind mapping, as described by Buzan (2018), serves as a potent think-aloud tool, visually presenting the internal process of the minds. Aligned with Ausubel's (1960) view on organisers for meaningful learning, research sup-ports mind mapping as an instructional tool that enhances reading comprehension, stimulates critical thinking, promotes metacognitive awareness, and encourages active engagement. The visual and graphic nature of mind mapping supports learners' com-prehension and retention of information, consistent with the findings of Vanichvasin's (2021) study that underscores the importance of visuals in the learning process.

Nation (2001) explored the relationship between receptive and productive word knowledge, where receptive knowledge involves understanding word form, meaning, and usage, while productive knowledge entails contextual use. Mind mapping by activat-ing associated thinking and utilising an associative network of images and words, visu-ally leverages the brain's capabilities for effective word knowledge. This understanding directly impacts a reader's ability to comprehend words in context and predict overall comprehension (Stahl, 2005). Consistent research highlights mind mapping's effective-ness in storing and retrieving vocabulary knowledge for reading comprehension and enhancing critical thinking skills (Hazaymeh & Alomery, 2022; Merchie & van Keer, 2016; Mohaidat, 2018; Riahi & Pourdana, 2017; Saori, 2020; Shi & Tsai, 2022; Yan & Kim, 2023).

Comparative studies emphasise mind mapping's superiority over traditional interactive reading with focused attention in aiding the storage and retrieval of vocabulary knowledge for reading comprehension. The key reasons behind this effectiveness lie in the visual representation of the relationships between words and concepts, creating associations between words and sensory information (Prabha & Aziz, 2020; Shi & Tsai, 2022; van der Wilt et al., 2019). By integrating theories on word knowledge and the use of mind mapping, educators can facilitate the development of students' receptive and productive word knowledge, enhance their comprehension skills, and support their overall learning experience. Effective word knowledge and the utilisation of mind maps as thinking tools synergistically contribute to improved language understanding and retention. They also help generate and expand ideas and express them orally, resulting in students' improvement in reading comprehension and motivation in reading classes (Cahyani et al., 2015; Saori, 2020). These findings align with Ausubel's (1960) perspective on using organisers to facilitate meaningful learning and retention of new knowledge.

Incorporating insights from existing literature, the research framework adopted in this study is built upon two well-established theories: the mind mapping theory and the UbD model. Consequently, the research model, UbD Mind Walker, has been developed to enhance participants' vocabulary size through the application of encoding and retrieval techniques. This specifically includes associated and elaborated word use, phrases reading, key words finding, and contextual reading facilitated by mind mapping (see Fig. 1).

Methodology

To assess the effectiveness of the UbD Mind Walker model and examine its impact on the development of participants' reading skills, a qualitative research design was implemented. The research spanned a duration of 11 weeks, during which the results were documented through a comprehensive review of all tasks undertaken by the participants. This approach allowed for a detailed exploration of the model's influence on various aspects of reading skill development, providing valuable insights into its efficacy. The essential question that guided the research is whether participants will be empowered in their vocabulary knowledge and usage to achieve independent reading through the UbD Mind Walker Model.

Research setting and participants

This study was conducted in an elementary school located in eastern Taiwan, which had a total student population of 52. Three participants, S1 (Y6), S2 (Y5), and S3 (Y6), were selected for the research based on their higher level of interest and motivation towards English language learning compared to their peers. However, it is important to note that when compared to urban students, these participants represented the bottom 30% in terms of the average level of English learning achievement. The researchers obtained parental consent for the participation of the students, as they were considered minors under 18 years of age.

Research framework and hypotheses

The Mind Walker experiment aims to enhance participants' reading skills by employing the mind mapping theory and UbD model to develop effective learning strategies.

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The Mind Walker experiment comprises three distinct stages, designed to encourage participants to re-evaluate their existing lexicon and subsequent reading skills. It was to facilitate participants' understanding of the importance of vocabulary development and the role of structure in reading comprehension. Additionally, it is anticipated that the designed framework would increase participants' reading awareness, leading to improved performance on various mind mapping tasks. The research began by using mind mapping as a pre-reading technique to assess participants' prior knowledge of a word and its concept. The research hypotheses are as follows:

(1) Incorporating the UbD Mind Walker experiment, which utilises word association and keyword finding, would enhance participants' vocabulary acquisition and their use of English;

(2) Participants' increased vocabulary acquisition and use of English would result in improved short and long-text comprehension;

(3) Participants' enriched text comprehension could help them familiarise themselves with different reading tasks, leading to significant growth and enhancement in reading comprehension.

To examine these hypotheses, participants were guided to engage in the mind mapping activities presented in Figs. 1 and 2. These activities encompassed three stages: (1) Mind Walker I: the road to brainstorming, aimed at assessing the impact of mind mapping on participants' English vocabulary skills, (2) Mind Walker II: the road to writing for identifying keywords or textual clues in reading, and (3) Mind Walker III: the road to reading comprehension. Please refer to Table 1 for a detailed class schedule outlining the progression of these activities.

Research tools

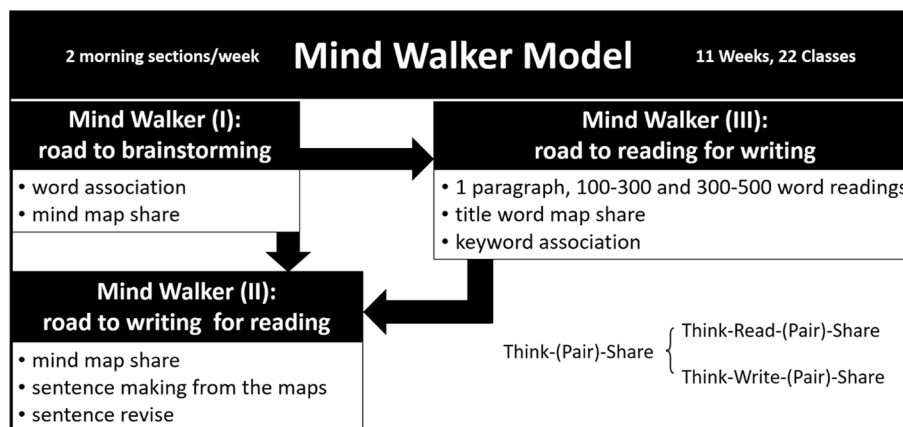(1) Tool 1: mind walker word card set:

Fig. 2 Research framework

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Table 1 Class procedure

Mind walker I	Picture–word	Sentence writing and story telling
1st class	Apple, arm, ask	Apple, Arm, Ask
2nd class	Bag, box, boy	Bag, Box, Boy
3rd class	Baby, ball, book	Baby, Ball, Book
4th class	Back, bad, bird, black	Back, Bad, Bird, Black
5th class	Big, brother, buy, cat, cup	Big, Brother, Buy, Cat, Cup
6th class	Call, cloudy, coat, colour, cow	Call, Cloudy, Coat, Colour, Cow
		One Paragraph Reading (Keywords)
7th class	Coke, cold, come, cook, cry	Coke, Cold, Come, Cook, Cry
8th class	Dance, desk, dirty, dog, draw	Dance, Desk, Dirty, Dog, Draw
9th class	Father, fly, foot, four, fun	Father, Fly, Foot, Four, Fun

Mind walker II	Word–picture	100–300 word reading (keywords)
10th class	Happy, have, head, hello	Our Favourite Food, Hat on the Head Saying "Hello" to People, Boy with Happy Face
11th class	Help, home, hot, house, hungry	The Losing Money Pocket, My House Where Do You Live?, The Hottest Day Ever
12th class	Ice cream, jacket, job, jump, mom	Making Ice Cream, Jacket, Mother's Day We Can Do Different Jobs, Bungee Jumping
13th class	Kite, late, lion, look, make	The High–Flying Kite, Late for School, It's Dinner Time Look Before You Leap, The Lion and The Mouse
14th class	New, old, park, pet, pizza	Maya's New Backpack, 100 Years of History, My Pet Dog What's on Your Pizza?, A Day at The Park
15th class	Pie, rainy, read, ride, school	How to Make Apple Pie, My Favourite Hobby The Weather is Rainy, Bike Ride, School Words
16th class	Seventeen, sky,spring, star, summer	Springtime, Things in The Sky, My Sweet 17 Birthday Summer Nights, Stars
17th class	Sunny, swim, tea, teacher, tiger	The Weather is Sunny, Swimming Lessons Do Tigers Like Monkeys?, Tea Time, My Favourite Teacher

Mind walker III	Word–picture	300–500 word reading (keywords)
18th class	Tree, watch, winter, work, write, year, zoo	The Blackbird and The Cherry Tree, Watching Cartoons Visiting My Father's Office, A Letter, Winter New Year, Connie's Visit to The Zoo
19th class	Flower and light (from 1000–word list)	Glossaries, Sky Colour
20th class	City, dangerous, and post office (from 1000–word list)	New York, Firefighter, The Post Office
21st class	Christmas and classroom (from 1000–word list)	My Best Friend, Sirowa, Starts a New School in England"
22nd class	Airplane, family, and celebrate (from 1000–word list)	My First Airplane Trip, My Lovely Family, Mother's Day Celebration

The Mind Walker Word Card Set, comprising 247 picture-word cards, was developed by choosing words from a pool of three hundred words and the one thousand must-learn-word-list established by the Taiwanese Ministry of Education. The purpose of this set was to help participants broaden their vocabulary and establish connections with related concepts, thereby improving their lexical knowledge and enhancing their understanding of vocabulary usage. This compilation excludes articles, prepositions, b-verbs, interrogative words, and third–person personal pronouns.

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The images used in the set were sourced from the public domain picture bank (see Fig. 3).

In the first step of the mind mapping process, participants were required to generate related words for specific target words and then form a sentence using the words written on cards. The utilisation of mind mapping and sentence–construction techniques served as a catalyst for subsequent reading activities, aiming to observe the participants' application of their lexical understanding. Participants were expected to connect the picture card to familiar words, building a word association bank (Fig. 4). It is hypothesised that the participants' ability to use context to recognise words would aid in comprehending the English reading texts as they constructed sentences using those related words.

(2) Tool 2: reading texts:

Throughout the brainstorming sessions, the participants consistently utilised mind mapping techniques while engaging with a diverse range of reading materials associated with the Mind Walker Word Card Set. The texts provided varied in length, spanning from concise one–paragraph passages to more extensive ones comprising 100–300 and 300–500 words, as illustrated in Figs. 5, 6, and 7.

To initiate the process, the participants initially collaborated while engaging with a short story that was read aloud. This exercise aimed to foster confidence in comprehending the texts. As the sessions progressed, the participants shifted their focus to
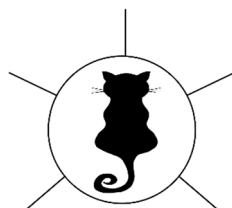

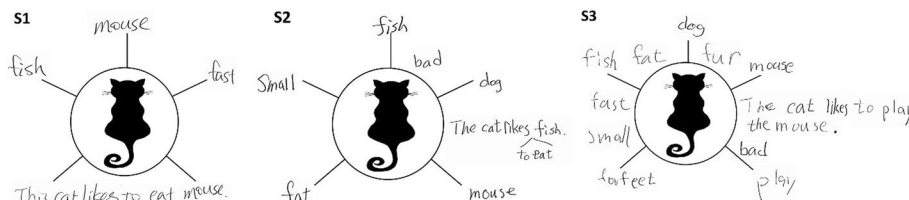**Fig. 3** Sample mind mapping picture-word card

Fig. 4 Sample word association and sentence making

Cat

My cat likes to eat fish, but she is afraid of mice. Every day, she goes to her favorite spot for dinner. And, of course, she feels happy after her dinner. (1 para.)

Cat

My cat likes to eat fish, but she is afraid of mice. Every day, she goes to her favorite spot for dinner. And, of course, she feels happy after her dinner. (1 para.)

Fig. 5 One paragraph reading sample

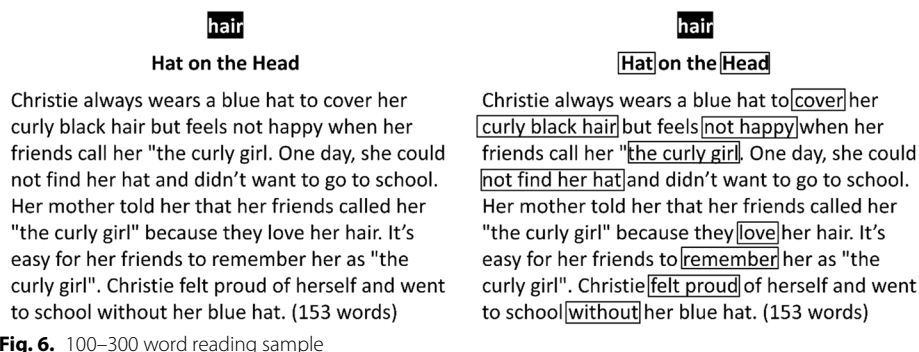Yen *Asian. J. Second. Foreign. Lang. Educ.* (2024) 9:43

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Fig. 6. 100–300 word reading sample

one−paragraph stories, where their task involved identifying related words from the story titles and uncovering essential keywords within the given context.

In addition to providing reading materials, various reading and discussing tasks were offered in every reading session to help participants brainstorm. These tasks included small talks, guided questions, yes/no questions, determining true or false statements, selecting from multiple choices, matching, and writing short answers for longer texts (see Fig. 7). To provide participants with immediate feedback on their reading comprehension, help them identify areas for improvement, and assess their understanding of the material, the reading tasks were introduced while the participants were reading.

By employing this approach, participants were expected to effectively establish a connection between the story's title and its central idea, thus employing a valuable reading tactic based on the contextual stimulus. The objective was for participants to approach the reading material by contemplating the words and structure within the context, rather than solely focusing on finding correct answers. Consequently, the reading texts were deliberately crafted to encourage participants to independently and skilfully employ mind mapping techniques, thus enhancing comprehension as they progressed through the text.

(3) Tool 3: pre- and post-tests:

For the pre-test and post-test, the reading texts utilised were official materials provided by the AA County Bureau of Education specifically designed for the annual county English Reading Contest. These texts were carefully selected to match an elementary level of difficulty. The tests employed a variety of question formats, primarily multiple choice, to assess the participants' comprehensive reading skills. The questions covered various aspects, including vocabulary, grammar, detailed comprehension, interpretation of main ideas or central themes, as well as the ability to make logical deductions based on the content of the readings. The pre-test was administered before the Mind Walker experiment began to establish a baseline of the participants' initial knowledge and reading strategies. This allowed for measuring and evaluating their abilities before any intervention occurred. Subsequently, a post-test was conducted three months after the completion of the experiment to assess the participants' long-term retention of the vocabulary knowledge and reading strategies they acquired during the Mind Walker intervention.

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airplane

First Airplane Trip
Story By: Judie Eberhardt

School was finally out. Now I will get to go to California to visit my favorite aunt, Aunt Helen. Aunt Helen came to our house two years ago, and now that I am a big girl, I am going to fly to her house all by myself! I'm so excited. Mom was going to take me to the airport and stay until the plane left the ground. I didn't know what to expect. Mom and Dad told me how the fly attendants would make sure I was in the correct seat and even ask me what I wanted to drink. The next day, we were off to the airport. Mom showed me the way to the security checkpoint. Then a lady at the gate checked my ticket and into the big plane I went. Another lady helped me find my seat and put my bag in the overhead compartment. Next, I buckled up and was ready for takeoff. The pilot came on the loud speaker and told everyone to prepare for takeoff. That's when I became so scared! No one told me that the plane would be so high in the air so fast! All the houses and cars looked like tiny ants. For a moment, I lost my breath, because I was so scared. The flight attendant could see that I was afraid. She came over and sat next to me in the empty seat. "Are you OK?" she asked. "Yes, just a bit scared because this is my first airplane trip." "I see," answered the flight attendant. "There is nothing to be afraid of." "Just sit back and relax." "Try to enjoy the view." "What is your name?" "I'm Linda." She then brought me a soda to drink. After drinking my soda, I fell asleep for a while, until I heard the pilot say, "Prepare for landing." "The temperature in Los Angeles is 75 degrees and sunny." With that announcement, I knew I was almost to Los Angeles and that Aunt Helen would be waiting for me at the gate when I got off the plane. As I went down the plane and into the airport, I saw Aunt Helen waiting for me by the ticket counter. I ran to her, and she gave me a big hug. "Did you enjoy your first airplane trip?" asked Aunt Helen. "I did, but it was a little scary at first." "The nice flight attendant took good care of me," said Linda. "I'm looking forward to the flight home." "Hold it just a minute," said Aunt Helen. "You just got here, and we have a week of fun things to do." "You can't run home too soon. Linda smiled a big smile. (451 words)

airplane

First Airplane Trip
Story By: Judie Eberhardt

School was finally out. Now I will get to go to California to visit my favorite aunt, Aunt Helen. Aunt Helen came to our house two years ago, and now that I am a big girl, I am going to fly to her house all by myself! I'm so excited. Mom was going to take me to the airport and stay until the plane left the ground. I didn't know what to expect. Mom and Dad told me how the fly attendants would make sure I was in the correct seat and even ask me what I wanted to drink. The next day, we were off to the airport. Mom showed me the way to the security checkpoint. Then a lady at the gate checked my ticket and into the big plane I went. Another lady helped me find my seat and put my bag in the overhead compartment. Next, I buckled up and was ready for takeoff. The pilot came on the loud speaker and told everyone to prepare for takeoff. That's when I became so scared! No one told me that the plane would be so high in the air so fast! All the houses and cars looked like tiny ants. For a moment, I lost my breath, because I was so scared. The flight attendant could see that I was afraid. She came over and sat next to me in the empty seat. "Are you OK?" she asked. "Yes, just a bit scared because this is my first airplane trip." "I see," answered the flight attendant. "There is nothing to be afraid of." "Just sit back and relax." "Try to enjoy the view." "What is your name?" "I'm Linda." She then brought me a soda to drink. After drinking my soda, I fell asleep for a while, until I heard the pilot say, "Prepare for landing." "The temperature in Los Angeles is 75 degrees and sunny." With that announcement, I knew I was almost to Los Angeles and that Aunt Helen would be waiting for me at the gate when I got off the plane. As I went down the plane and into the airport, I saw Aunt Helen waiting for me by the ticket counter. I ran to her, and she gave me a big hug. "Did you enjoy your first airplane trip?" asked Aunt Helen. "I did, but it was a little scary at first." "The nice flight attendant took good care of me," said Linda. "I'm looking forward to the flight home." "Hold it just a minute," said Aunt Helen. "You just got here, and we have a week of fun things to do." "You can't run home too soon. Linda smiled a big smile. (451 words)

Fig. 7. 300–500 word reading sample (Eberhardt, 2014)

Research procedure

The experiment took place over a period of 1 weeks, with sessions held twice a week, each lasting twenty minutes before the participants' regular morning classes. The scheduling of classes followed a well-defined procedure, deviating from the traditional approach of assigning classes based on predefined time slots. Instead, the readiness of the participants determined the progression to the next stage. The smooth execution of these three stages hinged upon providing clear explanations within a context-rich and captivating mind mapping strategy.

(1) Mind walker I:

The initial stage, Mind Walker I, involved participants utilising concept generation and mind mapping techniques to restructure their comprehension of word knowledge. The words used in this stage were sourced from Tool 1: The Mind Walker Word Card Set. Classes 1–6 focused on brainstorming target word associations to expand their word usage within relevant contexts. In the brainstorming phase, participants were allotted a maximum of 5 min to generate ideas. Following this time frame, they shared their mind maps with each other, engaging in discussions to enhance their understanding of the connections between concepts and words. This sharing session played a crucial role as it provided an opportunity for participants to express agreement or disagreement before revising their mind maps for the second round. Once the second mind map was completed, participants were tasked with constructing sentences using the words associated with the target word. The aim of this activity was to deepen participants' awareness that the same words could yield diverse texts. The generated words were also utilised to create stories, which served as a warm–up activity for the subsequent class. These stories were to prepare participants for the reading phase following their writing practice in stages one and two.

(2) Mind walker II:

In Mind Walker II, participants applied mind mapping techniques to extract keywords and enhance their comprehension of one–paragraph passages from Tool 2. From week 4 onwards, participants were expected to complete the mind mapping activity for the target words before the next class, fostering their reading confidence. As the course progressed, sentence-making and storytelling activities were occasionally replaced by reading a single paragraph starting from the 7th class. At this stage, a specific "read to the critical point" strategy was introduced. While reading, participants were instructed to identify and circle 5 keywords within 5 min that they considered crucial and central to the reading text's title. They then created a new mind map incorporating these selected keywords. During the sharing session, participants presented their revised mind maps and engaged in discussions to assess the extent to which the chosen words served as key elements or clues within the readings. This process enabled them to compile a list of the main components of the assigned text.

(3) Mind walker III:

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Moving to Mind Walker III, participants focused on extracting essential information from longer reading texts of 300–500 words, while disregarding irrelevant details. Participants were able to include up to 10 keywords on their reading mind maps. Following the map sharing, they were assigned the task of constructing a sentence using the identified keywords, akin to the exercise conducted in class 1. As participants advanced to reading more extensive texts, they engaged in various reading tasks, including answering yes/no questions, true or false statements, multiple–choice questions, matching exercises, and providing short answers. As the texts became more intricate, the reading tasks necessitated more in–depth content analysis. At this stage, thinking and reasoning skills were involved when the participants started to make inferences. For a comprehensive understanding of the Mind Walker Reading Programme, Table 1 offers an overview of the vocabulary covered, the corresponding reading texts employed, and the final processing involved.

To facilitate independent reading through interactive text engagement, the research includes the step of empowering learners in their vocabulary knowledge and usage. This is achieved through the following procedure:

(1) Vocabulary Knowledge: Provide participants with comprehensive instruction and practice in vocabulary acquisition, including understanding word meanings and appropriate usage.

(2) Vocabulary Usage: Encourage participants to actively use the acquired vocabulary in various contexts, such as reading titles and keywords.

(3) Active Engagement: Foster participants' active engagement with reading materials by promoting their interaction with titles and keywords. This involves teaching strategies for effective comprehension and interpretation of texts based on vocabulary understanding.

(4) Independent Reading: Support participants in developing independent reading skills by enabling them to confidently and proficiently read texts without extensive external guidance or assistance. This is accomplished through continuous practice, feedback, and reinforcement of vocabulary knowledge and usage.

Data analysis

Mind mapping and vocabulary empowerment

The ability to comprehend written text is closely tied to vocabulary, requiring a comprehensive grasp of words for full content comprehension. A limited vocabulary poses a hindrance to comprehension, impacting communication effectiveness. Addressing this challenge involves enhancing students' vocabulary size. The experiment commenced with word association to activate contextual reading among words. Figure 8 displays the word counts of 3 participants on their original mind maps for each class with the assigned words before engaging in think-read-share and think-write-share activities. In the initial 6 classes, all participants faced challenges with word association on mind maps. However, as they began to employ memory strategies such as grouping, associating/elaborating, contextualizing, using imagery, semantic mapping, keywords, and structured reviewing, their vocabulary retention and usage improved. This aligns with
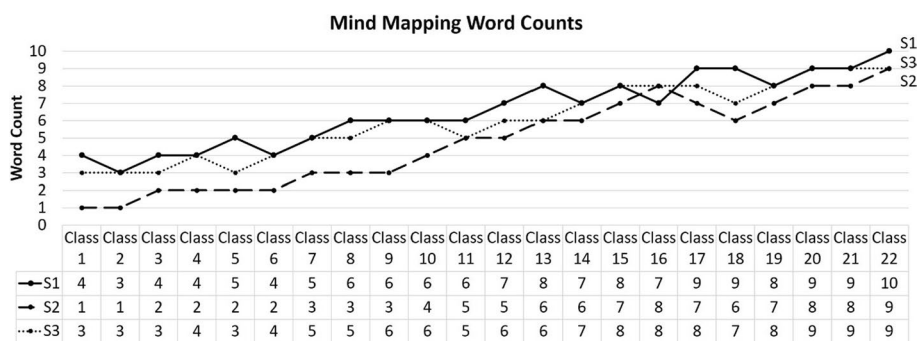
Mind Mapping Word Counts

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13	Class 14	Class 15	Class 16	Class 17	Class 18	Class 19	Class 20	Class 21	Class 22
S1	4	3	4	4	5	4	5	6	6	6	6	7	8	7	8	7	9	9	8	9	9	10
S2	1	1	2	2	2	2	3	3	3	4	5	5	6	6	7	8	7	6	7	8	8	9
S3	3	3	3	4	3	4	5	5	6	6	5	6	6	7	8	8	8	7	8	9	9	9

Fig. 8 Mind mapping word counts

Time Spent on Mind Mapping

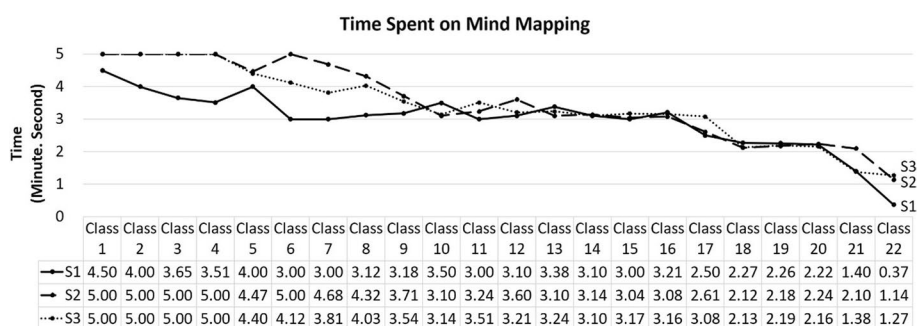|	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13	Class 14	Class 15	Class 16	Class 17	Class 18	Class 19	Class 20	Class 21	Class 22
S1	4.50	4.00	3.65	3.51	4.00	3.00	3.00	3.12	3.18	3.50	3.00	3.10	3.38	3.10	3.00	3.21	2.50	2.27	2.26	2.22	1.40	0.37
S2	5.00	5.00	5.00	5.00	4.47	5.00	4.68	4.32	3.71	3.10	3.24	3.60	3.10	3.14	3.04	3.08	2.61	2.12	2.18	2.24	2.10	1.14
S3	5.00	5.00	5.00	5.00	4.40	4.12	3.81	4.03	3.54	3.14	3.51	3.21	3.24	3.10	3.17	3.16	3.08	2.13	2.19	2.16	1.38	1.27

Fig. 9 Time spent on mind mapping

the theories of Oxford (1990) and Zlotnik and Vansintjan (2019), which emphasise that memory can be enhanced through various strategies, including visual imagery in encoding and the use of retrieval cues.

Based on the findings presented in Fig. 8, it was observed that S1 consistently demonstrated a higher level of word association with the target words compared to S2 and S3 throughout the 11-week period (22 classes). However, through multiple modelling sessions and guided practice over time, S2 and S3 exhibited gradual improvement in their mind mapping skills. This was achieved through the implementation of think-read-share and think-write-share activities, showcasing the ease and enjoyment of word association and boosting participants' motivation in mind mapping. While word association is a valuable skill, it is equally important for participants to comprehend the contextual usage and appropriate application of those words in diverse settings. Therefore, assessing word association performance and documenting the time spent on mind mapping is essential to evaluate the effectiveness of the activity.

In the initial 6 classes, participants encountered challenges in word brainstorming, often struggling until the last second due to their difficulties in retrieving known vocabulary. However, from the 7th class onwards, they gained confidence in vocabulary retention and contextual association, beginning to think aloud about all the assigned words through their word mind mapping with a consistent decrease in timing. Specifically, S1 reduced the time from 4 min and 50–37 s, S2 from 5 to 1 min and 14 s, and S3 from 5 to 1 min and 27 s. Despite initially slower progress in associated word production, S1 showed remarkable improvement by the final class, completing 10 associated words in

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just 37 s. In comparison, S2 and S3 generated 9 words in 1 min and 14 s, and 1 min and 27 s, respectively (refer to Figs. 8 and 9).

In comparison, S1 exhibited advanced mind mapping skills and outperformed the other participants by the 9th class, S2 and S3 also demonstrated satisfactory performance in the final week. The use of memory and contextual strategies positively impacted participants' proficiency in mind mapping and word association, as shown in Fig. 9. The reduced time spent on building mind maps indicates an improved ability to retrieve words from contexts, affirming the effectiveness of guided practice and feedback in enhancing participants' mind mapping skills and word association performance. This confirms that mind mapping visually connects words and concepts, forming associations with sensory information that assists participants in interactive reading with focused attention and facilitating the storage and retrieval of vocabulary knowledge (Prabha & Aziz, 2020; Shi & Tsai, 2022; van der Wilt et al., 2019).

Vocabulary empowerment and reading skills in english

Developing a profound understanding of when and how to effectively use associated words goes beyond having a large vocabulary. It is crucial to recognise that an increase in the number of associated words produced does not necessarily indicate complete mastery of word knowledge or its application. In the middle stage of Mind Walker I (class 7), participants were tasked with reading given texts and creating 5–10 keyword maps within 10 min, depending on the text length. The target word mapping continued with the same routine. Despite a quick response to word association, participants hesitated in choosing keywords due to fear of missing any single word. Subsequently, participants were instructed in sentence parsing, title reading, textual clue finding, and summarisation, preparing them to demonstrate proficiency in identifying keywords. Considering both time spent and keyword count, performance tracking began from class 10 onward (see Fig. 10).

Despite having enriched vocabulary knowledge, the participants needed more improvement in their ability to identify key points in the readings. At this stage, they officially started their Mind Walker II, which involved readings of 100–300 words. Afterward, in class 18, they progressed to Mind Walker III, which encompassed readings of 300–500 words. However, it is important to note that Fig. 11 highlights the participants' initial poor comprehension performance. Their scores remained below 60 from classes 10–14. Despite demonstrating improved knowledge and usage of the learned words, the participants faced challenges in making inferences about the
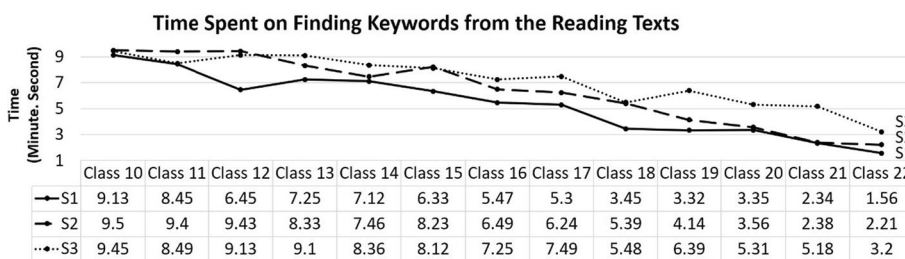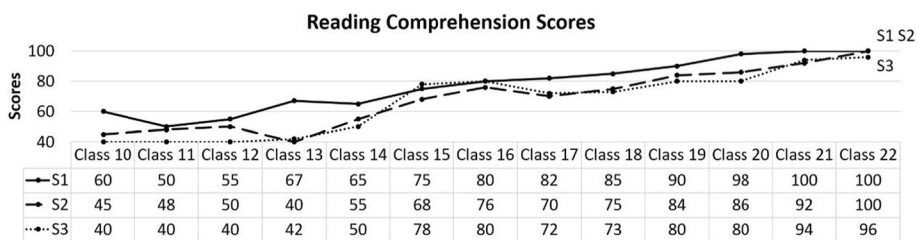

Time Spent on Finding Keywords from the Reading Texts

	Class 10	Class 11	Class 12	Class 13	Class 14	Class 15	Class 16	Class 17	Class 18	Class 19	Class 20	Class 21	Class 22
S1	9.13	8.45	6.45	7.25	7.12	6.33	5.47	5.3	3.45	3.32	3.35	2.34	1.56
S2	9.5	9.4	9.43	8.33	7.46	8.23	6.49	6.24	5.39	4.14	3.56	2.38	2.21
S3	9.45	8.49	9.13	9.1	8.36	8.12	7.25	7.49	5.48	6.39	5.31	5.18	3.2

Fig. 10 Time spent on finding keywords from the reading texts

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Reading Comprehension Scores

	Class 10	Class 11	Class 12	Class 13	Class 14	Class 15	Class 16	Class 17	Class 18	Class 19	Class 20	Class 21	Class 22
S1	60	50	55	67	65	75	80	82	85	90	98	100	100
S2	45	48	50	40	55	68	76	70	75	84	86	92	100
S3	40	40	40	42	50	78	80	72	73	80	80	94	96

Fig. 11 Reading comprehension scores

Pre-Test and Post-Test Scores

	Pre-Test	Post-Test 1	Post-Test 2
S1	83	100	100
S2	76	93	94
S3	63	91	90

Fig. 12 Reading comprehension scores

reading texts. This suggests that they continued to rely on the habit of grammar-translation reading, which could potentially delay their future reading endeavours.

According to McNamar et al., (2011), if a reader fails to establish a surface-level representation, their comprehension of the text may lack coherence. This means that without a proper understanding of words and the ability to parse sentences, the reader's comprehension at the surface level will be deficient, resulting in an incoherent or distorted understanding of the text. To address this issue, the participants in this study were encouraged to create keyword maps as a surface-level reading strategy. They were then prompted to explain the significance of these keywords in understanding the texts and how they contributed to the overall meaning. This process required participants to recall central ideas from the reading texts based on the keywords they identified by analysing the sentences. After sharing their keyword maps, participants were instructed to read and share the target word maps they created at home.

The comparison between participants' word association maps and keyword maps proved to be an effective approach for extensive reading. These maps helped them extract and construct meaning while reading, identifying and connecting different parts of longer narrative texts. After immersing their word association skills, vocabulary use, and knowledge in the readings for seven weeks (13 classes), the participants showed improvements in their comprehension performance. These vocabulary recognition activities significantly contributed to empowering learners to leverage their existing word knowledge when engaging with more complex texts. This improvement can be attributed to the interaction between the participants' existing world knowledge and the texts they encountered during reading. Finally, the results obtained from pre- and post-tests conducted using the city government's test pool demonstrate a significant enhancement in reading comprehension accuracy (see Fig. 12). Participants

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who utilised the Mind Walker reading tool demonstrated improved understanding and comprehension of written text compared to their previous performance.

The findings of the study also indicate that instruction in mind mapping strategies significantly influences and enhances participants' contextual reading skills, furthermore, provides them with opportunities to perceive themselves as proficient readers. Mind Walker not only aided participants in recognising text features such as keywords, titles, and cohesion, but also enabled them to engage in reasoning processes, leveraging their acquired vocabulary knowledge, associations, and utilisation. These factors, in turn, contributed to their comprehension of English text. According to this perspective, reading comprehension performance is influenced by the extent of a reader's vocabulary use and knowledge and the cognitive demands posed by the text's characteristics. These demands can include the amount of information that readers must process within their limited cognitive resources.

As Vidal-Abarca et al. (2000) suggest, comprehension is more successful and profound when the reader activates relevant knowledge and integrates it with the information explicitly stated in the text. In essence, text comprehension is enhanced when the reader generates inferences while reading. This positive trend in comprehension performance can be observed from class 15 onwards, when the participants began to excel in reading comprehension tasks. The findings confirm that the participants' internalised vocabulary knowledge through word association and keyword finding, supporting independent reading and retention. This knowledge transfer is evident in various reading tasks, contributing to both short- and long-text comprehension. It helps participants become familiar with diverse reading tasks, leading to significant growth and enhancement in reading comprehension. Therefore, all the hypotheses are validated.

Conclusions

The Mind Walker Programme enhances participants' reading comprehension skills through a reflective teaching approach, emphasizing practicality and prioritizing vocabulary acquisition. Its systematic backward progression design ensures the effective enhancement of reading comprehension. Implementing an interactive approach based on the UbD intervention method, the programme integrates vocabulary knowledge, conceptual abilities, and cognitive tasks—integral factors in both the programme's desired outcomes and learners' comprehension. This fosters participants' improved vocabulary retention and cognitive cohesion. In this backward reading comprehension scaffold, participants developed independent reading skills through interactive text engagement, cultivating a lasting comprehension of the significance of vocabulary in reading comprehension and interpretation. The assessment evidence includes participants' maps in class as well as pre- and post-tests. Findings have significant implications for advancing more effective and accessible teaching strategies, particularly in resource-limited settings.

Significance of the study and practical application

As these developments unfold, the Mind Walker Programme has the potential to shape and enhance reading instruction for learners at various levels in any countries, catering both slower and advanced learners. While the concept of "must-learn vocabulary" in the current research may not be applicable universally, standard requirements for

vocabulary may manifest in different forms to ensure the development of reading comprehension skills among elementary school students. The Mind Walker Mode, being versatile, does not demand a specific style of materials but rather provides a scaffold for teachers in activating students to make connections between words and concepts, ultimately leading to better comprehension. It also assists students to acquire a broader vocabulary knowledge.

This model, inclusive of novice and pre-service teachers, is user-friendly and requires no additional resources. By emphasising critical thinking skills and knowledge application, this Mind Walker Programme promotes meaningful and impactful teaching and learning experiences in reading. It represents a promising approach, fostering the development of critical thinking, comprehension, and real-world application. The data collected from this study marks as an initial step towards using the Mind Walker Programme for vocabulary learning strategies, word knowledge, retention, memory, and reading comprehension. Further research and implementation are expected to reveal its transformative impact, particularly in resource-limited settings. The tool's significant contribution to the field of reading comprehension lies in its potential to enhance teaching and learning outcomes. Moreover, its adaptability to resource constraints further adds to its value.

Limitation and suggestion

The primary challenge in this research is the limited availability of students in remote areas who are willing to participate, resulting in a small sample size for the study. The restricted population in remote areas poses difficulties in selecting a larger and more diverse group of participants for research purposes. Despite this constraint, the study can still provide valuable insights and preliminary findings that contribute to the existing knowledge in the field. Future research can overcome this limitation to engage a larger number of students, either from urban schools or from medium-sized schools in remote areas, thereby enhancing the external validity and reliability of the research outcomes. Additionally, researchers might consider conducting comparative studies between urban and remote areas to better understand potential differences in English reading comprehension dynamics. By addressing these aspects, future research can contribute to a more robust and widely applicable knowledge base in the field of English learning in diverse settings.

Summary

The UbD Mind Walker Programme follows a backward design process, starting with the desired learning outcomes in reading comprehension and fostering an inclusive learning community that promotes peer interaction and cultural exchange. This aspect is crucial for improving English language learning outcomes for remote students in Taiwan. Creating an environment that values diversity and encourages collaboration empowers students to enhance their language skills and broaden their cultural and language understanding. It focuses on identifying the essential understandings, knowledge, and skills necessary for students to develop in reading. By implementing the UbD planning, participants initiated the process by recalling vocabulary knowledge and reinforcing its application through mind mapping. They expanded on the target words by

incorporating them into meaningful sentences which equipped them to further identify phrases and keywords in short passages. This is to enable participants to grasp that vocabulary knowledge and usage are crucial for actively engaging with reading materials. This approach ensures that the Programme aligns with specific goals and objectives, guiding the design of purposeful and effective instruction and activities. A crucial feature of the Programme is its integration of the must-learn vocabulary listed by the Taiwanese Ministry of Education, which elementary school students must learn before graduation. By incorporating this word list into the Programme, participants are able to retrieve their prior knowledge and develop a robust vocabulary, a critical component of reading comprehension.

The Mind Walker Programme goes beyond word decoding, placing a strongly emphasis on critical thinking skills, comprehension strategies, and applying knowledge in real-world contexts. The study findings underscore the importance of incorporating implicit and explicit instructions for pre-reading and during-reading activities. By paying closer attention to how words are potentially used, participants improved their contextual skills and reduced the time spent struggling with vocabulary. Participants can more effectively develop their critical reading skills by receiving explicit guidance and support for comprehension skills alongside vocabulary learning. The reflective and iterative nature of the Programme, combined with the UbD model, provides a holistic and efficient approach to reading instruction, ensuring participants develop a deeper understanding of the content. In conclusion, the UbD Mind Walker Programme takes a purposeful and comprehensive approach to reading instruction, focusing on desired learning outcomes and integrating must-learn vocabulary. It emphasises strategic instruction, critical thinking skills, and knowledge application. Moreover, the Programme's inclusive learning community and focus on real-world application contributes to improved English language learning outcomes for remote students in Taiwan.

Declarations

Ethics approval and consent to participate
Written informed consent was obtained from all participants' parents before the data collection.

Competing interest
There is no conflict of interest regarding the publication of this article.

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