

ENHANCING EFL TERTIARY LEARNERS' READING COMPREHENSION THROUGH VISUAL SUPPORT: INSIGHTS FROM DUAL CODING AND MULTIMEDIA LEARNING

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Abstract

This study investigated the impact of visual support on reading comprehension and student perceptions among EFL tertiary learners. Using a quasi-experimental, post-test-only design, two intact classes (N = 80) were assigned to a text-only control group and a visual-support experimental group, which received the same texts accompanied by images, diagrams, and simple infographic-style elements. Results showed that the experimental group significantly outperformed the control group on a 20-item reading comprehension test, with a large effect size, indicating a substantial benefit of visual support for comprehension. A perception questionnaire and open-ended responses revealed that students viewed visuals as helpful for understanding main ideas, organizing information, and dealing with difficult vocabulary and abstract concepts, as well as increasing interest and confidence. However, students also reported that overloaded, poorly aligned, or weakly signposted visuals could be confusing or distracting. The findings highlight the need for careful visual design and explicit multimodal strategy instruction in EFL reading classes.

Keywords: visual support; reading comprehension; EFL tertiary students; multimodality; dual coding theory

1. INTRODUCTION

Reading comprehension is a core component of academic literacy for university students, particularly in English-medium programmes where success depends on the ability to process complex texts efficiently. Research in higher education shows that many EFL tertiary learners still struggle with reading tasks because of limited vocabulary, insufficient background knowledge, and weak use of reading strategies, which in turn affects their overall academic performance (Al-Jarrah & Ismail, 2018; Taladngoen et al., 2020). Recent studies in diverse contexts likewise report that students often find academic texts dense, abstract, and demotivating, and call for more supportive instructional approaches to develop their comprehension skills.

At the same time, university reading is increasingly embedded in multimodal environments. Learners now encounter texts that combine written language with images, diagrams, graphs, and other visual resources, both in print and digital formats. Multimodality research argues that contemporary literacy involves making meaning from these ensembles of modes rather than from written text alone (Kress, 2020; Serafini, 2014). In EFL contexts, integrating visual support into reading materials may be especially important, because visuals can scaffold

meaning when linguistic resources are still developing, and can make abstract academic content more accessible and engaging (Daulay & Dewi, 2025; Yu, 2015).

In this study, visual support refers to images, diagrams, and infographics that are presented alongside written texts. Prior research on visual aids in education suggests that such supports can direct attention, clarify relationships, and help learners build more coherent mental representations of content (Shabiralyani et al., 2015). Work in language education similarly indicates that carefully designed visuals can increase learners' motivation and support comprehension of literary and informational texts (Yunus et al., 2013). Studies with school-age EFL learners show that visual literacy work—such as interpreting pictures, charts, and other graphics in parallel with text—can contribute to improved reading comprehension outcomes (Fikri et al., 2024) and more positive attitudes toward reading tasks that incorporate visual aids (Pham & Nguyen, 2023).

The potential value of visual support in reading is grounded in well-established cognitive theories. Dual coding theory proposes that humans process information through separate but interconnected verbal and nonverbal systems; when information is encoded in both systems (for example, text plus image), learning and recall are enhanced (Clark & Paivio, 1991). In line with this view, studies of visual support in language learning argue that combining written input with pictures or diagrams creates multiple retrieval pathways, which can facilitate comprehension and retention of meaning (Sino, 2024).

Similarly, cognitive theory of multimedia learning (Mayer, 2009) posits that learners understand material better when words and pictures are integrated in ways that manage cognitive load—for example, when related text and visuals are closely aligned and unnecessary details are reduced. Experimental work comparing infographics with more traditional graphics-plus-text formats suggests that, under some conditions, infographics may support more durable learning, particularly when learners find them engaging (Lyra et al., 2016). Together, these theoretical perspectives provide a strong rationale for investigating how visual support can be used to enhance EFL learners' reading of academic texts.

Empirically, several studies have examined the effects of visual or multimodal input on reading-related outcomes. Fikri et al. (2024) reported that integrating visual literacy activities into reading instruction significantly improved junior secondary EFL students' comprehension scores. A multimodal literacy intervention in an Indonesian high-school context likewise found that students who received reading instruction using multimodal texts—including images and digital elements—outperformed those who worked only with traditional print texts (Daulay & Dewi, 2025). Other research has focused on learners' perceptions: Pham and Nguyen (2023) showed that Vietnamese ninth-graders generally held positive attitudes toward the use of visual aids in reading lessons and associated them with greater interest and understanding. Beyond reading, systematic reviews indicate that visual support tends to benefit vocabulary acquisition among young EFL learners and can increase motivation to engage with texts (Sino, 2024).

Nevertheless, it should be noted that most research on EFL reading strategy practice and implementation primarily took place at the primary or secondary educational level and involved limited research on EFL university students and academic reading materials supported with visual aids. Typically, current research at a university level concentrates on examining aspects like strategy utilization and anxiety, as well as overall reading difficulties among these

groups (Al-Jarrah & Ismail, 2018; Taladngoen et al., 2020). Moreover, as most research regards perceptions of EFL learners on various visual aids and tools (Pham & Nguyen, 2023; Yunus et al., 2013), there still appears to be limited evidence developing an understanding within an objective reading task performance and EFL learners' subjective perceptions on visual support within academic reading materials.

Addressing this gap, the present study investigates the impact of visual support on reading comprehension among EFL tertiary students. Grounded in dual coding theory and multimedia learning theory, it compares the reading comprehension performance of students who read texts with visual support to those who read text-only materials and explores how students themselves perceive the usefulness of visuals in aiding their understanding. Specifically, the study is guided by the following research questions:

1. RQ1: Does visual support (images, diagrams, or infographics) improve the reading comprehension performance of EFL tertiary students compared to text-only materials?
2. RQ2: How do EFL tertiary students perceive the usefulness of visual support in understanding reading texts?

By combining quantitative measures of comprehension with qualitative or survey-based data on learners' perceptions, this study aims to contribute to evidence-informed design of reading materials and classroom practices in university-level EFL contexts.

2. LITERATURE REVIEW

Reading at a tertiary level plays a vital role in a successful academic career, as it benefits students in reading complex texts effectively and developing critical thinking skills (Nasri, 2025; Patty et al., 2025). Proper reading strategies with visual support can greatly help in effective comprehension and critical analysis of texts in the English as a Foreign Language setting. Visual support tools like graphic organizers and multimedia can be extremely helpful in developing comprehension and critical analysis of EFL and ESL students in different studies (Lai & Mukundan, 2023; Johannes & Hashim, 2023; Qi & Jiang, 2021). These tools help in information management, as well as in actively engaging with texts, which ultimately results in successful comprehension and analysis results (Lai & Mukundan, 2023; Qi & Jiang, 2021). EFL students find it difficult to read academic texts owing to a lack of vocabulary, insufficient knowledge of a subject matter, and dense abstract reading matter associated with tertiary education (Patty et al., 2025). These issues are of prime importance as they can hamper students' capabilities of understanding and analyzing academic texts. The use of visual support tools would help students with EFL in overcoming various difficulties in reading, which would result in improved performance and understanding of subjects (Lai & Mukundan, 2023; Qi & Jiang, 2021). Using visual support also assists students in reading different concepts in class, and it also aids in understanding complex concepts, hence improving performance. The use of visual support tools in class becomes important for EFL students since it will help in reading as well as understanding complex concepts in class, including those of critical thinking. (Nasri, 2025; Qi & Jiang, 2021). Studies suggest that visual support tools, like graphic organizers, can greatly improve reading comprehension and retention in EFL students as it instills an active involvement with the text in class (Lai & Mukundan, 2023; Nasri, 2025; Qi & Jiang, 2021). Such approaches help students identify visual connections between notions, which in turn yields a deeper understanding of the subject matter.

Adding support with graphics and images to EFL reading classes goes beyond addressing linguistic problems because it exerts a positive influence on cognitive processing, thus leading to an increase in comprehension and performance among EFL learners (Mayer, 2005). Various pieces of research have shown that tools involving graphics and images, mind maps included, have shown to be highly useful tools that significantly impact reading comprehension and retention among learners positively because they interact with reading sessions meaningfully and effectively (Lai & Mukundan, 2023; Nasri, 2025; Qi & Jiang, 2021).

Furthermore, it has been seen that there are factors that might influence the implementation of graphic organizers, and these factors include the visual literacy level of EFL learners, as shown by Lai and Mukundan in 2023, and familiarity with graphic organizers, as shown by Qi and Jiang in 2021. Having pointed out these factors, it becomes easy for teachers to make decisions on ways and methods to better enable EFL learners to make efficient use of graphic organizers. From the above discussion, it can be seen that it becomes possible for EFL learners to make efficient use of graphic organizers and thus improve reading skills.

Visual support involves a range of features including images, pictorials, and infographics that help in summarizing information for better understanding in a learning setting. Visual support is vital in promoting comprehension in a learning setting where it offers students a visual representation that simplifies a piece of information, making it interesting and easy to understand (Johannes & Hashim, 2023). Visual support also has the potential to offer students a platform to relate new information to their previous knowledge. Effective visual support tools, such as graphic organizers and mind maps, can greatly enhance reading comprehension and retention skills in EFL students, which in turn would lead to a sharp improvement in their overall performance, as suggested by various studies, including those by Lai and Mukundan (2023); Nasri, 2025; and Qi and Jiang, 2021).

Images offer a key role in constructing meanings as they help students decode and make meanings out of the complex information, hence increasing their comprehension of academic knowledge. Additionally, these also help in decoding information, along with promoting a collaborative learning approach among students of EFL, hence increasing their comprehension of knowledge (Johannes & Hashim, 2023). Using visual elements in the learning process can greatly help in increasing students' capabilities in decoding complicated texts, as well as in their comprehension capabilities (Lai & Mukundan, 2023). Visuals help in decreasing the cognitive load of processing information in a better, more organized format, which further promotes efficiency in processing learning matter (Johannes & Hashim, 2023; Mayer, 2005). Using pictures in educational reading materials has been shown to improve students' engagement and comprehension, ultimately resulting in better reading comprehension performance in EFL situations; in this regard, Lai & Mukundan, 2023; Patty et al., 2025. Not only will using pictures make it easier for students to comprehend, but it will also encourage their engagement with educational reading, making it even simpler for EFL students. This can all be accomplished by using these strategies in educational reading.

Theoretical approaches like Schema Theory, Dual-Coding Theory, and so on, have significant importance regarding understanding and implementing visualization support for EFL understanding and retention. Dual-Coding Theory proposes that retention of information

related to memory occurs when it is processed either from the visual or auditory source. It becomes highly imperative for EFL learners because it helps them with understanding as well as retention regarding comprehension and retention related to intricate concepts within an EFL text. The theoretical approach also specifies that EFL requires visualization support. It aligns with cognitive functions associated with comprehension. Methods and procedures within visualization support, like mind maps and organizers, will thus enable EFL learners to develop efficient understanding and retention within EFL subjects with intricate concepts, ultimately leading to efficient academic success and achievement (Lai and Mukundan, 2023; Nasri, 2025; Qi and Jiang, 2021).

Mayer's Cognitive Theory on Multimedia Learning again emphasizes the importance of creating learning aids that are based on how the brain learns knowledge and thus improve efficiency in learning outcomes (Mayer, 2005). This becomes more imperative when teaching EFL, given that multimedia learning, together with other learning aids such as graphics organizers, have also been cited as learning tools that improve understanding among EFL learners with varying learning styles, as stipulated by Johannes and Hashim (2023), as well as Mayer (2005).

The Multimodality Framework promotes the use of different modes of communication that can lead to a better understanding of a text, which also makes it ideal for EFL students reading complex educational texts. This model aligns with a theoretical perspective that combining different modes of representation, like visual and text-based representation, can be an effective means of improving EFL students' understanding of educational texts (Johannes and Hashim, 2023). Multimodal practices are consistent with Dual-Coding Theory and theories of multimedia design. These theories support that using visual and text representation conjointly has a profound understanding and retention potential in EFL students. Additionally, using visual support strategies in EFL teaching not only solves comprehension issues, but it also provides a proactive and interesting platform for students in their acquisition of knowledge. Using visual support strategies in EFL teaching and learning, hence, provides a comprehensive solution to comprehension issues, along with an interesting platform for EFL students (Lai & Mukundan, 2023; Qi & Jiang, 2021).

There has been a substantial amount of empirical research investigating the effects of visual support on reading comprehension, vocabulary development, and inferencing abilities in different levels of education. In methodology, a major part of those studies used a quasi experiment/experiment with a preceding and a final test and were able to verify the effects of visual support, especially in using graphic organizers, on reading performance (Níkleva and Rodríguez-Muñoz, 2022; Loayon and Navare, 2025; Castillo et al., 2024; Lai and Mukundan, 2023). Mixed-method designs with additional qualitative analyses helped make sense of data from increased learner engagement and experiences with visual support as well (Bugtong et al., 2025; Daulay and Dewi, 2025). Some studies, though, used a small sample size, a one-group design with a preceding and a final test, a small amount of random assignment, and a short timeframe for interventions, which limit their validity for other situations, making it impossible to indicate that a result can be attributed only to interventions and their long-term effects as well (Castillo et al., 2024; Loayon and Navare, 2025; Amir et al., 2024; Jian, 2021; Elwerfalli, 2024; Noori, 2025; Rismawati and Somantri, 2025).

In general, visual support strategies have been shown to result in increased reading comprehension, especially for literal and global comprehension. Graphic organizer strategies, comic strips, and multimodal texts often result in substantial pre-test to post-test differences and substantial effect sizes in reading comprehension tasks (Níkleva & Rodríguez-Muñoz, 2022; Loayon & Navare, 2025; Bugtong et al., 2025; Lai & Mukundan, 2023; Daulay & Dewi, 2025). Digital technologies and multimedia approaches often support traditional methodologies in terms of engagement and comprehension, pointing towards the potential of technology-aided visual support strategies (Noori, 2025). Simultaneously, improvement in higher-order comprehension tasks are less common, with a few studies pointing towards small, trivial, and minimal improvement in various reading comprehension processes, especially in inferencing tasks (Salazar-Rodríguez, 2020; Désiron et al., 2021). Non-standardized instrument studies, lack of information concerning psychometric properties, and relatively fewer studies that explore inferencing comprehension make it challenging to draw a comprehensive conclusion from various studies concerning higher order comprehension outcome measurements (Castillo et al., 2024; Salazar-Rodríguez, 2020; Désiron et al., 2021; ZENKI-DALIPI et al., 2025).

Another prominent area of empirical research regards vocabulary acquisition and retention. Findings from studies reveal that visual/graphical aids like comic strips, infographics, flashcards, pictorial glosses, and multimedia support use has a profound positive impact on increasing and retaining vocabulary acquisition, as it has been found to lead to a noticeable improvement in pre-post and delayed post-test outcomes among students (Salem & Aust, 2007; Amir et al., 2024; Flores-González et al., 2024; González et al., 2024; Nhan, 2023; M.A, 2023). Multimodal MEDIA use has also been found to increase lexically deep engagement and retention for readers in long-term memory, as reported in several studies (Al-Sabbagh, 2023; Yanguas, 2009). However, evidence also suggests that pictorial/graphical support use effects are differentiated as a function of students' individual reading comprehension levels, whereby beginners may derive superior benefit but also struggle with visual interpretation tasks, including picture comprehension (Gruhn et al., 2020; Bates, 2017). Differences in vocabulary test type, choice of words, and lack of use of delayed retention strategies limit understanding of precise comparative analysis, as found in Saeed & Muhealddin, 2024; Liu, 2022.

Empirical studies also underscore the diversity of visual support types and their related pedagogical uses. Graphic organizers, including semantic maps, concept maps, KWL charts, and story maps, are proven to enhance reading comprehension, particularly for literal and inferential meanings, as well as help students synthesize a text's major ideas and foster critical thinking skills (Loayon & Navare, 2025; Castillo et al., 2024; Lai & Mukundan, 2023; Medina, 2018; Salazar-Rodríguez, 2020; Rahat et al., 2020; Peng, 2023; Imsa-ard, 2022; Ayiz & Warsono, 2018; Fernández & Mora, 2022). Comics, comic strips, including electronic ones produced by students, are found to enhance reading comprehension, as well as increase students' motivation, vocabulary mastery, and inference capabilities when employed as visual support tools in reading instruction (Bugtong et al., 2025; Rismawati & Somantri, 2025; Amir et al., 2024; Elwerfalli, 2024; Flores-González et al., 2024; Larisa et al., 2023; Azizah & Hamid, 2022; León, 2019; Lopez, 2022).

Videos, audio, infographics, and electronic visual supports, like interactive glosses, further enhance reading comprehension and knowledge of vocabulary, considering their emphasis on accommodating different types of students' learning styles as well as increasing additional support for students in reading instruction (Salem & Aust, 2007; Al-Sabbagh, 2023; Nhan, 2023; McDonald et al., 2023; M.A, 2023; Noori, 2025; Kim & Gilman, 2008; Fälth et al., 2022; Yanguas, 2009; Anari et al., 2019). In these studies, visual support features a robust retention of vocabulary, particularly for low-skilled students in EFL, as it increases their recall of vocabulary and comprehension of reading text, especially when employed in reading instruction for enhanced reading comprehension, as seen in studies with a focus on reading. More granular empirical research has been done to explore how visual-text alignment timing and congruency affect comprehension. The results explicitly show that aligning images either preceding and/or closely aligned with text, as well as promoting a high degree of visual-text congruency, decreases processing demands and enhances inferencing capabilities in subjects (ZENKI-DALIPI et al., 2025; Désiron et al., 2021; Rivero-Contreras et al., 2023). Empirical studies using a range of approaches, comprising standardized tests, test development, interviews, and eye-tracking analyses, have increased comprehension of visual information processing, as well as visual information benefits for comprehension and vocabulary development, among subjects (Jian, 2021; Rivero-Contreras et al., 2023; Pellicer-Sánchez et al., 2020; Níkle Rodríguez-Muñoz, 2022; Lai & Mukundan, 2023). On a different note, a lack of standardized tests and longitudinal studies continue to be prominent issues in visual information processing studies (Castillo et al., 2024; Salazar-Rodríguez, 2020; Jian, 2021).

Lastly, learner engagement and variation provide key themes for empirical studies. Qualitative data reveal that visual aids result in increased motivation, engagement, and positive attitudes with reading and vocabulary acquisition as students report enjoyment and benefit for comprehension (Loayon & Navare, 2025; Bugtong et al., 2025; Amir et al., 2024; Jaemsai & Sukying, 2025; Noori, 2025). Digital and student produced visual aids are most effective in developing a sense of ownership and resultant processing (Elwerfalli, 2024; Flores-González et al., 2024). Some students experience V ČR visual overload and/or lack needed vocabulary for benefiting from visual aids (Bugtong et al., 2025), though relatively fewer studies examine influences of age, level, and culture in determining visual support efficiency (Seng et al., 2024; Gruhn et al., 2020; Sun, 2023; Flores-González et al., 2024).

Studies performed in different countries around the globe, including Spain, Malaysia, Philippines, Iran, and Latin America, for example, indicate that visual support has a positive influence, though a modified factor remains in accordance with country-specific practices, class characteristics, and implementation acceptability in education reform policy and practices in all sectors of their respective nations. This has been cited in studies by authors like Núñez & Molina, 2024; Medina, 2018; Daulay & Dewi, 2025; Noori, 2025; Castillo, 2022.

Collectively, these empirical studies above reveal that a variety of visual support tools, such as graphic organizers, comic strips, infographics, and multimedia glosses, can effectively improve reading comprehension, vocabulary acquisition, and learner engagement, albeit with a mixed outcome in relation to long-term retention and higher-level comprehension (Lai & Mukundan, 2023; Bugtong et al., 2025; Daulay & Dewi, 2025; Salem & Aust, 2007; González et al., 2024). Notably, these studies also underscore that students in general have shown a positive attitude

towards visual support, but some students tend to feel overloaded or find it difficult to make effective use of visual support tools effectively (Loayon & Navare, 2025; Jaemsai & Sukying, 2025; Bugtong et al., 2025; Noori, 2025). However, there exist a limited number of empirical studies that examined tertiary-level EFL students in reading standardized academic texts, or compared comprehension performance of text-only and visually supported reading texts in relation to EFL tertiary students. This study fills in this theoretical gap to explore the potential benefits of visual support in promoting EFL tertiary students' reading comprehension (RQ1) as well as their attitudes towards visual support in facilitating reading comprehension of students (RQ2).

3. METHODOLOGY

3.1 Research Design

This study employed a quasi-experimental mixed-methods design. For RQ1, a nonequivalent control-group design compared the reading comprehension performance of students who read text-only materials with those who read the same texts accompanied by visual support (images, diagrams, or infographics). For RQ2, a brief questionnaire with Likert-scale and open-ended items was administered to the experimental group to explore students' perceptions of the usefulness of visual support.

This design was used because intact classes could not be randomly reassigned, and because both quantitative outcomes and qualitative perceptions were needed.

3.2 Context and Participants

The study took place at a private level tertiary institution offering EFL courses in Oman. Participants were intermediate to upper-intermediate EFL tertiary students enrolled in a reading/skills-based course. Two intact classes were selected through convenience sampling:

- Experimental group: texts with visual support
- Control group: text-only versions

Each group comprised 40 students (total 80). All had several years of prior English study and experience with academic or semi-academic reading. Participation was voluntary and had no impact on course grades.

3.3 Materials

Two parallel sets of reading materials were used:

Text-only versions

- Continuous texts of about 600–800 words, appropriate to the students' proficiency level.
- Selected or adapted from authentic or semi-authentic sources (e.g., graded readers, ELT materials, short informational articles) on general academic topics.

Text + visual support versions

- The same texts accompanied by visuals, including images illustrating key ideas, diagrams summarizing relationships, and simple infographic-style elements (e.g., charts, timelines).
- Visuals were taken or adapted from reputable sources, kept equivalent in content, and positioned close to the relevant text to ensure clear text–image alignment.

Texts for both groups were matched for topic, length, and difficulty; only the presence or absence of visual support differed.

3.4 Instruments

3.4.1 Reading Comprehension Test

For each target text, a reading comprehension test of 20 items was developed to assess literal, inferential, and global comprehension. Item types included multiple-choice and short-answer questions. Two EFL colleagues reviewed the tests for content validity (level, clarity, and alignment with objectives), and a small pilot administration was carried out to check clarity and estimate reliability.

3.4.2 Student Perception Questionnaire

To address RQ2, the experimental group completed a perception questionnaire after the comprehension test. It included:

1. **Likert-scale items** on:
 - perceived usefulness of visual support for understanding the text,
 - perceived impact on motivation, interest, and confidence,
 - perceived clarity and helpfulness of the visuals.
2. **Open-ended items** (e.g., “How did the visuals help you understand the text?”; “Were there any parts where the visuals did not help or were confusing?”).

The questionnaire was piloted for clarity and language level, and minor wording adjustments were made accordingly.

3.5 Procedure

The procedure was as follows:

1. **Orientation and consent**
 - The purpose of the study was explained to both classes.
 - Students were informed that participation was voluntary, anonymous, and unrelated to their grades.
2. **Grouping and conditions**
 - One class was assigned as the experimental group (text + visuals), the other as the control group (text-only).
 - Both groups followed the same lesson plan and teacher to reduce instructional differences.
3. **Reading and testing**
 - Each group received its respective version of the reading text in a regular class.
 - Students read individually under normal classroom conditions.
 - Immediately afterwards, they completed the corresponding reading comprehension test (about 20–30 minutes).
4. **Perception data (experimental group only)**
 - The experimental group then completed the perception questionnaire (about 10–15 minutes), providing both scaled responses and short written comments.

The full sequence (reading, test, and questionnaire) was completed within one extended session or two regular class periods.

3.6 Data Analysis

3.6.1 RQ1: Reading Comprehension Performance

Reading comprehension scores were analyzed quantitatively. Descriptive statistics (means and standard deviations) were calculated for both groups, and an independent-samples *t*-test compared the mean scores of the text-only and visual-support conditions. Effect sizes (e.g., Cohen's *d*) were computed to estimate the magnitude of any differences. Where applicable, analyses focused on post-test scores.

3.6.2 RQ2: Student Perceptions

Likert-scale responses were summarized using descriptive statistics (means, standard deviations, and frequencies) to give an overview of students' perceptions of visual support. Open-ended responses were coded thematically, and recurrent themes (e.g., "easier to understand main ideas," "helps remember vocabulary," "can be distracting at times") were identified and illustrated with representative comments. These analyses provided both numerical trends and qualitative insight into how students experienced visual support in reading.

3.7 Ethical Considerations

Ethical guidelines were followed throughout the study. Students were informed about the purpose and procedures of the research, and consent was obtained. They were reminded that they could withdraw at any time without penalty. No identifying information was collected on tests or questionnaires, and results were reported only in aggregate form. Institutional and departmental approval was sought and obtained before data collection.

3. ANALYSIS

In order to investigate the impact of visual support on EFL tertiary students' reading comprehension (RQ1), the post-test scores of the control (text-only) and experimental (text + visuals) groups were subjected to a series of quantitative analyses. The presentation begins with descriptive statistics to characterize group performance, and then reports the results of an independent-samples *t*-test and associated effect sizes to evaluate whether the inclusion of visuals produced a statistically and educationally meaningful advantage.

a. Impact of Visual Support on Reading Comprehension (RQ1)

Table 1

Descriptive statistics for reading comprehension scores by condition (post-test, N = 80) (Maximum possible score = 20)

| Condition | n | Mean | SD | SE | 95% CI for Mean (LL–UL) |
|-------------------------------|----|-------|------|------|-------------------------|
| Control (Text-only) | 40 | 11.90 | 2.33 | 0.37 | 11.16 – 12.64 |
| Experimental (Text + visuals) | 40 | 14.90 | 2.27 | 0.36 | 14.17 – 15.63 |

The descriptive statistics indicate a clear performance advantage for the visual-support condition. The control group (text-only) obtained a mean score of 11.90 (SD = 2.33, SE = 0.37), whereas the experimental group (text + visuals) achieved a higher mean of 14.90 (SD = 2.27, SE = 0.36) on the same 20-item comprehension test. The 95% confidence interval for the control group's mean (11.16–12.64) does not overlap with the central region of the experimental group's mean interval (14.17–15.63), suggesting that the difference is not due to

sampling fluctuation alone. Variability in scores was comparable across groups ($SD \approx 2.3$ in both cases), implying that the introduction of visual support produced an upward shift in the overall distribution of scores rather than simply increasing or decreasing dispersion.

Table 2

Levene's test and independent-samples t-test for post-test comprehension scores

| Statistic | Value |
|---|-------------|
| Levene's test for equality of variances: $F(1, 78)$ | 0.08 |
| Levene's test p -value | .77 |
| Mean difference (Experimental – Control) | 3.00 |
| SE of difference | 0.51 |
| 95% CI for mean difference (LL–UL) | 1.98 – 4.02 |
| $t(78)$ | 5.83 |
| p (two-tailed) | < .001 |

Prior to the group comparison, Levene's test was used to examine the homogeneity of variances. The test was non-significant, $F(1, 78) = 0.08$, $p = .77$, indicating that the equal-variance assumption was satisfied and that the pooled-variance independent-samples t -test was appropriate.

The mean difference between groups was 3.00 points on a 20-point scale, with a standard error of 0.51 and a 95% confidence interval ranging from 1.98 to 4.02. The corresponding t -value was 5.83 with 78 degrees of freedom, yielding a highly significant result ($p < .001$). Thus, students who read the visually supported text outperformed those who read the text-only version by approximately three test points, and the confidence interval for this difference does not approach zero, indicating that the effect is both statistically reliable and unlikely to be trivial in practical terms.

Table 3

Effect size indices for the difference between text-only and visual-support conditions

| Effect size index | Value | Interpretation |
|------------------------------------|-------|--|
| Cohen's d (pooled SD) | 1.30 | Large effect |
| Hedges' g | 1.29 | Large effect |
| Point-biserial correlation (r) | 0.55 | Large; $\approx 30\%$ variance explained |

To gauge the size of this difference, various measures of effect size were computed. On the basis of the pooled standard deviation, the value of Cohen's d was 1.30, which was well into the "large" category. Using the small sample correction, Hedges' g was 1.29, which reinforced this finding. This means that a value of d , or g , of 1.3 would indicate that, on average, students in the experimental group scored over a full standard deviation above those in the control group. The point biserial correlation value was $r \approx .55$, which was also taken to be a large effect size. Squaring this value, it appears that about 30% of the variation in reading comprehension achievement for students in either the experimental group or the control group was due to the experimental condition rather than in the control condition. Taken collectively, these data suggest that a sizeable and significantly important difference, rather than a small improvement,

occurred in comprehension performance due to visual support. Overall, there appears to be a consistent trend from descriptive statistical analysis, through hypothesis testing, to estimates of effect size that suggests visual support significantly and greatly improved reading comprehension in EFL tertiary students.

b. Perceptions of Tertiary Students on the Usefulness of Visual Support in Understanding Reading Texts (RQ2)

Analysis of open-ended data from 40 students in the experimental group revealed that the use of visuals was perceived as a supportive device for understanding, particularly in identifying key concepts, text structure, and abstract information. This perceived benefit of using visuals was evident in comments that showed how students found that “diagrams, flowcharts, timelines, and concept maps” were useful in enabling students to “see the main idea of each section” of a text and “see how different ideas in the text were related” (Students 1, 7, 10, 29). Other students found that using visuals enabled a “quick check” of their understanding of a text, which enabled students to check “if their understanding of a paragraph was the same as in a picture” in order to “correct any mistakes right away” (Students 5, 36). Visuals were also considered a supportive device in processing unfamiliar words and abstract concepts, as students found that using pictures and diagrams enabled them to conclude “without using a dictionary so often” and that understanding complex concepts was now “more concrete” and “remembered better” (Students 3, 15, 32).

Together with this cognitive support, students also reported a strong positive affective component. Throughout their answers, students reported that the inclusion of visuals in reading would make it “less boring,” “less formal and intimidating,” and “more like active learning than just decoding text” (Students 2, 8, 27). While many of these students reported that the inclusion of visuals alleviated anxiety and boosted their confidence in reading, as they felt that they now “had more than one way of understanding the text” and were “not alone with the difficult text” (Students 7, 12, 37). Some students also reported that since they resembled “real” types of reading, such as reading in class or in a professional setting, that these visually enhanced texts seemed more relevant and hence boosted their participation in this task (Students 6, 17, 26).

Simultaneously, analysis of the students’ comments has also highlighted design and understanding issues in certain visuals that impacted their use. These comments grouped around issues of visual overload, whereby students found visuals such as “graphs with too many arrows,” “graphs with too many colors,” or “graphics with tiny text” were “overwhelming” and, as a consequence, students chose to “skip parts” of a visual or even a visual altogether (Students 1, 3, 22, 37). There were also comments about being confused by unknown symbols, abbreviations, and graph scales, which in some instances led students to make “incorrect interpretations” until rereading either the text and/or visual (Students 7, 18, 24). Visual text dissonance, whereby students found inconsistencies between text and visual in their order, emphasis, and/or terminology, resulted in students being unsure of which to “believe” in certain instances, with students “having to take extra time” to resolve discrepancies between text and visual narratives (Students 13, 29, 35). A third set of comments focused negatively on “decorative” visuals, which were deemed “pretty” but in no way improved understanding and were hence “a distraction” for students rather than “a help” in understanding their texts, as described by students 8, 28, 31.

Another theme highlighted how and when students are supposed to use these visual elements. Some students were not sure of when it was appropriate for them to refer to the visual elements, either prior to reading, as they are reading, in every paragraph, or just paragraphs completed, “to jump between text and pictures” (Students 2, 19, 23). Orientation in reading, where visual elements are situated beyond the page, including in a position where it takes a long time to refer back, caused students to skip reading visual elements altogether, especially if it follows closely after a passage has been read (Students 5, 36).

Throughout this data set, students were able to provide concrete recommendations on how visual support needs to be designed and utilized in class. There were students that pointed out that visual support needed captions that would clearly identify what the visual represents, like “Summary of Section 2” and “Cause-effect diagram,” as well as “See Figure 1” cues in text, as shown in quotes from students 2, 20, and 40. There were also those that would like to see simpler designs, fewer components, bigger fonts, limited colors, and standardized symbols in visual support, as pointed out in quotes from students 6, 22, and 37. There were also students that would like visual support, comprehension questions, and text in class to complement, rather than repeat, conflict with, and repeat text, as shown among students 14, 25, 33, and 35. Lastly, there were students that specifically asked for a strategy on how to use visual support quickly, like when to look, what to look for, especially in more complicated graph and picture designs, as shown in quotes from students 18, 19, and 31.

Taking everything into consideration, it can be ascertained that the qualitative data suggests that students experience a lot of benefit from visual support for reading EFL texts, especially when these visual supports are designed in a proper manner, aligned with the text, and incorporated along with reading strategies. On the other hand, if visual support lacks proper design and/or proper alignment with text, it can cause confusion in students.

Table 1: Thematic grouping of perception items.

| Theme | Items included | Focus | Mean score (range) |
|----------------------------------|-----------------|--|--------------------|
| Cognitive learning support | / 1, 2, 3, 4, 7 | Understanding overall meaning, main ideas, vocabulary/concepts, remembering content, confidence in answering questions | 4.00 (3.88–4.15) |
| Interest, motivation, future use | and 5, 6, 8 | Enjoyment of the activity, motivation to read carefully, preference for similar visuals in future readings | 3.83 (3.73–3.88) |
| Design, clarity, and integration | 9, 10, 11, 12 | Clarity of visuals, relevance to content, placement, and (non-)distracting support | 3.72 (3.65–3.80) |

(Means based on 1–5 scale; higher scores indicate more positive perceptions.)

Taken together as groups, it was found that ratings were highest in items concerning cognitive support and understanding, that is, Items 1, 2, 3, 4, and 7. The average value in this group was 4.00, with a range of 3.88 to 4.15. This point indicates that students were very much aware of

the use of visuals in understanding overall meanings, in coping with tough vocabulary/concepts, in remembering text, and in becoming confident in responding to comprehension questions. Perceptions of design, clarity, and integration (Items 9, 10, 11, 12) were a bit more mixed, though still above the middle of this scale ($M=3.72$). There was agreement with Item 10 that the visuals were clear, relevant, and helped rather than being distracting, but the slightly lower means in this set of items are consistent with comments in open-ended questions.

The data from perception suggests that EFL university students found visual support to be a functional tool of comprehension, as opposed to mere ornamentation surrounding reading texts. High values on scales concerning reading comprehension, key comprehension, vocabulary, and confidence, coupled with themes of “cognitive scaffolding” and “self-testing” for reading comprehension, are in line with expectations from Dual-Coding Theory. “Viewing a visual to identify the key idea, to help facilitate understanding of all this information, and then to check my own understanding concerning this text” encapsulates Paivio's recommendation that “learning takes place when verbal input is accompanied by pictorial input that corresponds with it.” In other words, a verbal and pictorial coding system appears to be operating in a complementing role.

The results also correlate closely with those from the Cognitive Theory of Multimedia Learning. Indeed, a number of students noted that the use of visuals aided in dealing with complex or cluttered information, such as processes, comparisons, and concepts, which indicated that, possibly, well-designed visuals decreased extraneous cognitive loads and enabled viewers to develop a mental model of the information. Meanwhile, their criticisms of the visual aids—that they were “too cluttered,” “overloaded with colors,” difficult to read, and misaligned with text—reflect similar principles of CTML, such as Coherence, Signal, Spatial Contiguity, and Redundancy. However, when these principles were deemed violated—when fonts were small, when different concepts used different terminology, and when a visual was placed in a remote location from the text of a related paragraph—students found it confusing, effortful, and even avoided it, which especially suggests that visual aids are not effective in all situations but are, in fact, text-visual design-sensitive.

In relation to this, in a multimodal analysis, students were conceptualized as constructing reading as not only a linguistic event but as a signification practice involving multiple modes—verbal, visual, spatial, and graphical—jointly. This observation aligns with various definitions of multimodality, which see signification as an embodied practice that involves multiple modes, where meanings are not contained in words but in a semiotics of bodily actions, including visual imagery. This also appears to align with observations that students felt as though the texts were “authentic” or “real-world” when accompanied with visual imagery, as students felt that text with visual imagery was more “engaging” than straight text. However, it also appears from this data that students are not able to use multimodal resources effectively without instruction. The lack of understanding of when to refer to these resources and how to use them upon reading a text, as well as when to refer to symbols used in these resources, suggests that students are in need of strategy instruction. Some students asked for direct instruction on how to use visual sources effectively, with some asking for “Summary of Section 2” and “See Figure 1” instructions. This point to the necessity of not only using Dual

Coding Theory and CTML in visual design, but also strategy instruction in visual reading, especially among students with lower levels of proficiency.

In sum, on the basis of quantitative and qualitative data, it appears that visual support, when carefully designed and integrated, has been seen as both cognitively supportive and affectively motivational for EFL tertiary-level students. At the same time, the data also indicates that in certain cases, visual support has introduced further difficulties. This has important implications for both education and design, namely that a twofold approach should be taken: on the one hand, applying long-standing principles of multimedia and multimodality in picture design and placing, and on the other, teaching students how to decode multimodal texts as part of normal readings in an EFL setting.

4. CONCLUSION

This research focused on the effects of visual support on reading comprehension among EFL university-level students in relation to their attitudes towards it. Through a quasi-experimental design, it has been found that students who were reading text supported with visual components, including images, graphs, and infographic boxes, performed greatly better in a 20-item comprehension test in comparison to those who were reading text-only versions of the texts. Through this, it can be claimed that due to visual support, students experience a significant enhancement in comprehension rather than a mere marginal improvement.

The perception data complemented these findings in that it showed that students believed that visuals were seen not merely as enhancements, but as cognitive tools that facilitated understanding of key concepts, text structures, challenging vocabulary, and complex ideas as well as making reading more interesting and less threatening. Nonetheless, students also found that there were established limits to these supports. Visuals that were cluttered, misplaced, insufficiently signposted, and crowded with colours and details were, at times, sources of puzzlement, cognitive overload, and distraction. These are consistent with findings from Dual-Coding Theory, Cognitive Theory of Multimedia Learning, and approaches to multimodality, which support that the use of visual support in reading is not merely a matter of presence but of design.

Pedagogically, it appears that there are two tasks for EFL practitioners in tertiary education: firstly, to provide relevant visual support that has a natural connection with text and which has been allocated in a way consistent with conventional principles of multimedia design, and secondly, to provide instruction in strategies that help students learn when and how to make use of visual support as part of their natural reading processes. On the issue of quasi-experiments, intact groups, and a focus on a specific setting, it must be noted that unless otherwise indicated, findings from such studies are to be considered in a qualified way. Further studies which take a longitudinal approach, examine different types of visual support, and consider degrees of visual support for different types of texts would be an interesting extension of this study. Nonetheless, in spite of this, this study has found, in a robust way, that visual support has a role for EFL tertiary students in increasing comprehension and engagement with reading texts.

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