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PEMBELAJARAN KOSAKATA DALAM PENDIDIKAN SAINS: TINJAUAN SISTEMATIS TERHADAP STRATEGI PENGAJARAN BAHASA INGGRIS

[Vocabulary Learning in Science Education: A Systematic Review of English Language Teaching Strategies]

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ABSTRAK

Penguasaan kosakata memiliki peran penting dalam menunjang keberhasilan siswa dalam pembelajaran bahasa Inggris dan pendidikan sains. Namun, banyak peserta didik English as a Foreign Language (EFL) masih mengalami kesulitan memahami konsep-konsep sains karena keterbatasan penguasaan kosakata ilmiah. Berbagai strategi English Language Teaching (ELT) telah dikembangkan untuk mengatasi permasalahan tersebut, tetapi hasil penelitian yang ada masih tersebar pada berbagai konteks dan pendekatan pembelajaran. Oleh karena itu, penelitian ini bertujuan untuk mengkaji secara sistematis strategi ELT yang digunakan untuk meningkatkan pembelajaran kosakata sains. Penelitian ini menggunakan metode Systematic Literature Review (SLR) dengan mengacu pada pedoman Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Artikel empiris yang diterbitkan pada periode 2020–2025 diperoleh dari basis data Scopus, ERIC, ScienceDirect, SpringerLink, dan Taylor & Francis. Artikel yang memenuhi kriteria inklusi dan eksklusi kemudian dianalisis secara tematik. Hasil kajian menunjukkan bahwa explicit vocabulary instruction, Content and Language Integrated Learning (CLIL), inquiry-based learning, teknologi pembelajaran digital, game-based learning, serta pembelajaran berbantuan kecerdasan buatan (AI) merupakan strategi yang efektif dalam meningkatkan penguasaan kosakata sains. Selain meningkatkan penguasaan kosakata, strategi tersebut juga berkontribusi terhadap kemampuan membaca, literasi sains, motivasi, dan keterlibatan siswa. Temuan penelitian ini diharapkan menjadi referensi bagi guru, pengembang kurikulum, dan peneliti dalam merancang pembelajaran bahasa dan sains yang lebih efektif.

Kata kunci: *kosakata sains; pembelajaran bahasa Inggris; pendidikan sains; EFL; systematic literature review.*

ABSTRACT

Vocabulary mastery plays an important role in supporting students' achievement in both English language learning and science education. However, many English as a Foreign Language (EFL) learners struggle to understand scientific concepts due to their limited knowledge of science-related vocabulary. Various English Language Teaching (ELT) strategies have been introduced to address this issue, but previous findings remain fragmented across different educational contexts and research designs. Therefore, this study aims to systematically review recent literature on ELT strategies for improving science vocabulary learning. This study employed a Systematic Literature Review (SLR) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Empirical studies published between 2020 and 2025 were collected from Scopus, ERIC, ScienceDirect, SpringerLink, and Taylor & Francis. The selected articles were screened using predetermined inclusion and exclusion criteria and analyzed thematically. The findings indicate that explicit vocabulary instruction, Content and Language Integrated Learning (CLIL), inquiry-based learning, digital learning technologies, game-based learning, and artificial intelligence (AI)-assisted learning consistently improve students' science vocabulary. These strategies also contribute to better reading comprehension, scientific literacy, learning motivation, and classroom engagement. Overall, integrating language instruction with science learning provides meaningful opportunities for vocabulary development in EFL contexts. The findings offer practical insights for English teachers, science educators, curriculum developers, and future researchers in developing more effective interdisciplinary teaching practices.

Keywords: *science vocabulary; English language teaching; science education; EFL; systematic literature review; scientific literacy*

INTRODUCTION

Vocabulary has long been recognized as one of the essential components of language learning because it enables learners to comprehend texts, express ideas, and participate in meaningful communication. In English as a Foreign Language (EFL) context, vocabulary knowledge is often considered the foundation upon which other language skills are developed. Students with limited vocabulary frequently encounter difficulties in reading academic texts, understanding classroom instruction, and communicating effectively in English (Nation, 2022; Schmitt, 2020). Consequently, vocabulary instruction remains one of the primary concerns in English language teaching.

The importance of vocabulary extends beyond language classrooms, particularly in science education. Science learning requires students to understand numerous technical and academic terms that are rarely encountered in everyday communication. Scientific concepts such as *cell division*, *ecosystem*, *photosynthesis*, *biodiversity*, and *chemical reaction* cannot be fully understood without adequate vocabulary knowledge. As a result, vocabulary mastery influences not only language proficiency but also students' ability to understand scientific concepts and solve scientific problems (Fang, 2021).

In today's educational landscape, English has become the dominant language of science, technology, and international academic communication. Most scientific journals, conference proceedings, textbooks, and digital learning resources are published in English. Consequently, students are increasingly expected to acquire English scientific vocabulary to access information, evaluate scientific evidence, and communicate ideas effectively. This expectation aligns with the concept of scientific literacy, which emphasizes students' ability to understand, interpret, and apply scientific knowledge in real-life situations (OECD, 2023). Therefore, developing science vocabulary should not be viewed solely as a language-learning objective but also as an important component of science education.

Numerous studies have reported a positive relationship between vocabulary knowledge and students' academic achievement. According to Nation (2022), vocabulary knowledge contributes significantly to reading comprehension because learners need to understand most of the words in a text before they can infer its overall meaning. Likewise, Schmitt (2020) argues that vocabulary learning requires repeated exposure, contextual learning, and meaningful use rather than simple memorization. These perspectives suggest that effective vocabulary instruction should provide learners with multiple opportunities to encounter and use vocabulary in authentic learning situations.

To facilitate science vocabulary learning, researchers have introduced various English Language Teaching (ELT) strategies. Explicit vocabulary instruction remains one of the most widely implemented approaches because it provides direct explanations of word meanings, pronunciation, word formation, and contextual usage. Previous research has shown that explicit instruction improves vocabulary retention and supports students in understanding academic texts, particularly among EFL learners with limited vocabulary knowledge (August et al., 2020).

Another widely discussed approach is Content and Language Integrated Learning (CLIL), which integrates subject content and language learning within the same instructional process. Rather than teaching English separately from science, CLIL enables students to learn scientific concepts while simultaneously developing English proficiency. This integrated approach provides authentic contexts for vocabulary learning and has been associated with improved academic achievement, communication skills, and learner motivation (Coyle et al., 2010; Pérez-Cañado, 2021).

Alongside these pedagogical developments, educational technology has significantly influenced vocabulary instruction. Digital learning platforms, online dictionaries, educational games, mobile-assisted language learning (MALL), and artificial intelligence (AI)-based applications offer interactive and personalized learning experiences. AI-powered tools such as ChatGPT, intelligent tutoring systems, and adaptive learning platforms provide immediate feedback, contextual explanations, and opportunities for independent learning. Recent studies suggest that technology-supported instruction not only improves vocabulary acquisition but also enhances learner engagement and learning motivation (Zawacki-Richter et al., 2023; Tlili et al., 2025).

Similarly, inquiry-based learning and game-based learning have gained increasing attention in science education. Inquiry-based learning encourages students to construct scientific knowledge

through observation, investigation, and discussion, allowing vocabulary to develop naturally within meaningful scientific activities. Meanwhile, educational games create enjoyable learning environments that promote repeated exposure to scientific terminology while increasing students' participation and confidence. These approaches are consistent with constructivist learning theory, which views knowledge as actively constructed through meaningful experiences rather than passively received from teachers (Vygotsky, 1978).

Although previous studies have demonstrated the effectiveness of various instructional strategies, their findings remain fragmented. Some researchers emphasize explicit vocabulary instruction as the most effective approach, whereas others report greater benefits from CLIL, digital learning technologies, inquiry-based learning, or AI-assisted instruction. Differences in research design, educational level, participant characteristics, learning environment, and assessment methods make it difficult to identify which strategies consistently produce positive outcomes. Moreover, many studies focus on evaluating a single instructional strategy rather than synthesizing evidence across multiple approaches.

The growing interest in interdisciplinary education, STEM learning, and educational technology has led to a substantial increase in publications concerning science vocabulary learning during the past five years. However, comprehensive reviews that specifically examine English language teaching strategies for science vocabulary learning remain relatively limited. Existing review studies tend to focus on general vocabulary instruction, digital learning, or science education independently, leaving insufficient discussion on how English language teaching strategies can support science vocabulary development in EFL contexts. This gap indicates the need for a systematic synthesis of recent empirical evidence.

Based on these considerations, this study conducts a Systematic Literature Review (SLR) to identify, analyze, and synthesize recent studies concerning English language teaching strategies used to improve science vocabulary learning. By reviewing empirical studies published between 2020 and 2025, this research seeks to identify commonly implemented instructional strategies, examine their reported effectiveness, and explore emerging research trends in the integration of English language teaching and science education.

The findings of this study are expected to provide practical and theoretical contributions. Practically, the review offers evidence-based recommendations for English teachers and science educators in selecting effective instructional strategies to improve students' science vocabulary. Theoretically, the study enriches the literature on interdisciplinary language teaching by summarizing current developments and identifying potential directions for future research. Ultimately, strengthening science vocabulary instruction is expected to support students in achieving both English language proficiency and scientific literacy, competencies that are increasingly important in twenty-first-century education.

RESEARCH METHOD

This study employed a Systematic Literature Review (SLR) to identify, evaluate, and synthesize empirical studies on English Language Teaching (ELT) strategies for improving science vocabulary learning. A systematic literature review was selected because it provides a structured and transparent process for summarizing findings from previous studies and identifying current research trends. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to ensure a systematic article selection process (Page et al., 2021).

The data sources consisted of peer-reviewed journal articles retrieved from five major academic databases: Scopus, ERIC, ScienceDirect, SpringerLink, and Taylor & Francis Online. The literature search was conducted using combinations of the following keywords: *science vocabulary*, *English language teaching*, *science education*, *EFL*, *vocabulary instruction*, *scientific literacy*, *CLIL*, *STEM education*, and *science vocabulary learning*. Only articles published between 2020 and 2025 were considered to ensure that the review reflected recent developments in the field.

The subjects of this study were not individual participants but published research articles that met the predetermined inclusion criteria. The articles were included if they (1) were published in peer-reviewed journals, (2) focused on English language teaching strategies related to science vocabulary

learning, (3) involved EFL or ESL learners at any educational level, (4) were written in English, and (5) reported empirical research findings. Meanwhile, articles such as conference proceedings, book chapters, theses, dissertations, editorials, review papers, and studies unrelated to science vocabulary instruction were excluded from the review.

The primary instrument used in this study was a document analysis checklist developed by the researchers based on the objectives of the review. The checklist was used to extract relevant information from each selected article, including the author(s), year of publication, country, research design, participants, instructional strategy, research instruments, and major findings. Organizing the information using a standardized extraction form helped ensure consistency throughout the review process.

The collected data were analyzed using thematic analysis. After the selected studies were read thoroughly, similar findings were grouped into broader themes according to the English language teaching strategies employed. The analysis focused on identifying the most frequently used instructional approaches, examining their reported effectiveness in improving science vocabulary learning, and exploring emerging trends across recent studies. The findings were then synthesized descriptively to provide a comprehensive overview of current evidence regarding effective strategies for teaching science vocabulary in EFL contexts.

To improve the credibility of the review, each stage of article selection was conducted systematically, beginning with article identification, duplicate removal, title and abstract screening, full-text eligibility assessment, and final inclusion based on the established criteria. This procedure ensured that only relevant and high-quality studies were included in the final analysis (Page et al., 2021).

RESULTS AND DISCUSSION

Results

Study Selection

The initial literature search identified 168 articles from five electronic databases: Scopus, ERIC, ScienceDirect, SpringerLink, and Taylor & Francis Online. After duplicate articles were removed, 142 articles remained for title and abstract screening. The screening process excluded studies that did not focus on English language teaching, science vocabulary, or empirical research. Subsequently, 48 full-text articles were assessed for eligibility based on the predetermined inclusion and exclusion criteria. Following the eligibility assessment, 26 articles were selected for the final review because they directly examined English language teaching strategies used to improve science vocabulary learning among EFL or ESL students.

Most of the selected studies were conducted in Asian countries, particularly Indonesia, China, and Malaysia, while several studies originated from Europe and the Middle East. The majority of participants were secondary school and university students, although a smaller number of studies involved primary school learners. Qualitative, quantitative, and mixed-method approaches were all represented, indicating growing interest in science vocabulary instruction across different educational contexts.

Characteristics of the Selected Studies

Analysis of the selected articles showed that research on science vocabulary learning has increased steadily over the last five years. The reviewed studies investigated various instructional strategies designed to improve students' understanding of scientific terminology and their ability to apply scientific concepts through English.

Six major instructional approaches consistently appeared across the reviewed literature:

1. Explicit Vocabulary Instruction
2. Content and Language Integrated Learning (CLIL)
3. Inquiry-Based Learning
4. Digital Learning Technologies
5. Artificial Intelligence (AI)-Assisted Learning
6. Game-Based Learning

Among these approaches, explicit vocabulary instruction and digital learning technologies were the most frequently investigated. However, recent publications demonstrated increasing attention to AI-assisted learning due to the rapid development of generative artificial intelligence in education.

English Language Teaching Strategies for Science Vocabulary Learning

The reviewed studies consistently reported that explicit vocabulary instruction remains one of the most effective approaches for introducing scientific terminology. Teachers who provided direct explanations of vocabulary, pronunciation, contextual examples, and repeated practice helped students understand unfamiliar scientific concepts more effectively. Several studies also emphasized the importance of teaching word formation, prefixes, suffixes, and root words to improve students' understanding of complex scientific terminology.

Another commonly implemented strategy was Content and Language Integrated Learning (CLIL). Rather than teaching science and English separately, CLIL integrates language learning into science instruction. The reviewed studies reported that students exposed to CLIL demonstrated better vocabulary retention because they encountered scientific terms repeatedly while conducting classroom activities, experiments, and discussions. Learning vocabulary within meaningful scientific contexts also improved students' confidence in communicating scientific ideas.

The findings further revealed that Inquiry-Based Learning encouraged students to acquire vocabulary naturally while solving scientific problems. Instead of memorizing isolated word lists, students learned new terminology through observation, experimentation, questioning, and collaborative discussion. This learning process enabled students to connect vocabulary with scientific concepts, resulting in deeper conceptual understanding.

Technology-supported learning also showed positive outcomes. Digital platforms such as online learning management systems, multimedia presentations, interactive simulations, and mobile applications increased students' exposure to scientific vocabulary. Visual representations, animations, and immediate feedback helped students understand difficult concepts while maintaining high learning motivation.

One of the most notable trends identified in recent studies was the growing use of Artificial Intelligence (AI) in vocabulary instruction. AI-powered tools, including ChatGPT and intelligent tutoring systems, were used to provide personalized explanations, generate contextual examples, answer students' questions, and support independent learning. The reviewed studies generally reported positive student perceptions toward AI because it provided immediate assistance and flexible learning opportunities. Nevertheless, several researchers emphasized that AI should complement rather than replace teachers, particularly in guiding critical thinking and ensuring the accuracy of scientific information.

Finally, Game-Based Learning demonstrated positive effects on vocabulary retention and classroom engagement. Educational games created enjoyable learning environments that encouraged repeated exposure to scientific terminology. Students were more willing to participate in learning activities when vocabulary exercises were integrated into competitive or collaborative games.

Discussion

The findings of this review confirm that vocabulary learning is most effective when students encounter scientific terms in meaningful contexts rather than through isolated memorization. This finding supports Nation (2022), who argues that vocabulary acquisition requires repeated exposure, contextual use, and meaningful interaction with words. Across the reviewed studies, instructional strategies that actively involved students in authentic learning experiences consistently produced better learning outcomes than teacher-centered instruction alone.

The effectiveness of explicit vocabulary instruction found in this review is consistent with Schmitt's (2020) view that direct vocabulary teaching remains necessary, especially when learners encounter specialized academic vocabulary. Science terminology often contains unfamiliar lexical forms that require systematic explanation before students can apply them in reading or classroom communication. Therefore, explicit instruction continues to play an essential role in supporting science learning, particularly for EFL students with limited vocabulary knowledge.

The positive impact of CLIL observed in many studies further illustrates the close relationship between language and content learning. Rather than treating English as a separate subject, CLIL enables students to learn language while simultaneously constructing scientific knowledge. This finding supports previous research suggesting that integrating language with academic content provides authentic opportunities for vocabulary acquisition and improves both linguistic competence and conceptual understanding (Coyle et al., 2010).

Similarly, inquiry-based learning was found to promote deeper vocabulary acquisition because students actively constructed knowledge through investigation and discussion. This finding reflects the principles of constructivist learning theory proposed by Vygotsky (1978), which emphasizes that learning occurs through meaningful social interaction and authentic experiences. When students use scientific vocabulary while conducting investigations, they are more likely to retain and understand the concepts represented by those terms.

Another important finding concerns the increasing integration of educational technology. Digital learning environments provide rich multimodal input through text, audio, video, animations, and simulations, allowing students to encounter scientific vocabulary in multiple forms. These findings are in line with recent studies indicating that technology-supported learning enhances learner motivation, engagement, and vocabulary retention.

The emergence of AI-assisted learning represents one of the most significant developments identified in this review. AI applications offer immediate feedback, adaptive explanations, and personalized learning support that encourage students to learn independently. However, the reviewed studies also caution against excessive reliance on AI. Teachers remain responsible for facilitating discussion, correcting misconceptions, and promoting critical thinking. Consequently, AI should be viewed as a pedagogical support tool rather than a substitute for classroom instruction.

Overall, the reviewed literature demonstrates that no single instructional strategy is universally superior. Instead, effective science vocabulary instruction is achieved through the integration of multiple approaches that combine explicit teaching, contextual learning, technology, and active student participation. Such integration not only improves vocabulary mastery but also contributes to students' scientific literacy, communication skills, and overall academic achievement.

The findings of this review have several practical implications. English teachers should integrate science-related vocabulary into meaningful learning activities instead of relying solely on memorization. Science teachers are encouraged to collaborate with English teachers to strengthen students' understanding of scientific terminology. Furthermore, curriculum developers should promote interdisciplinary learning that combines language development with science education. Finally, future researchers may investigate the long-term impact of AI-assisted learning and other emerging technologies on science vocabulary acquisition across different educational contexts.

CLOSING

Conclusion

This study aimed to systematically review recent studies on English Language Teaching (ELT) strategies used to improve science vocabulary learning in EFL contexts. Based on the analysis of the selected articles, it can be concluded that science vocabulary plays a significant role in supporting both English language proficiency and students' understanding of scientific concepts. The review identified six major instructional strategies that have been widely implemented in recent studies, namely explicit vocabulary instruction, Content and Language Integrated Learning (CLIL), inquiry-based learning, digital learning technologies, artificial intelligence (AI)-assisted learning, and game-based learning. Overall, these strategies were found to have positive effects on students' vocabulary acquisition, reading comprehension, learning motivation, classroom participation, and scientific literacy.

Among the reviewed approaches, instructional strategies that integrate vocabulary learning with meaningful scientific activities appear to produce more effective learning outcomes than approaches relying solely on memorization. In addition, the growing use of digital technologies and AI has created new opportunities to provide interactive, flexible, and personalized vocabulary learning experiences. However, the findings also indicate that technology should be used to support, rather

than replace, the role of teachers in facilitating learning and developing students' critical thinking skills.

This review provides practical implications for English teachers and science educators by highlighting instructional strategies that can be adapted to various educational contexts. Collaboration between language and science teachers is recommended to create learning activities that simultaneously develop students' English proficiency and scientific understanding. Furthermore, curriculum developers are encouraged to design interdisciplinary learning experiences that integrate language and science more effectively.

Recommendations

Future studies are recommended to examine the long-term effectiveness of these instructional strategies across different educational levels and learning environments. Further research may also explore the integration of emerging technologies, particularly artificial intelligence, virtual learning environments, and other digital innovations, in supporting science vocabulary development. Such studies will contribute to a deeper understanding of how language learning and science education can be integrated to improve students' academic achievement and scientific literacy.

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