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ARTICLE

Enhancing Chemistry Terminology Acquisition Through Morphological Awareness: Utilizing Derivation, Prefixes, and Suffixes in English

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ABSTRACT

The acquisition of scientific terminology poses a challenge for students, particularly in subjects like chemistry, where complex vocabulary is essential for understanding key concepts. This study investigates the effectiveness of morphology-based instruction, which emphasizes word derivation rules, prefixes, and suffixes, in enhancing students' comprehension and retention of chemistry terminology. Conducted with preparatory-year students at King Faisal University, the study employed a quasi-experimental design with an experimental group receiving morphology-based instruction and a control group following traditional memorization techniques. Pre-test and post-test assessments revealed that the experimental group demonstrated significantly greater improvement in terminology acquisition, with a mean gain of 35% compared to 18% in the control group. A delayed retention test further indicated that the experimental group retained more vocabulary over time, experiencing only a 5% loss, whereas the control group showed a 10% decline. Paired t-tests and ANOVA confirmed the statistical significance of these differences ($p < 0.05$). Additionally, student feedback indicated a strong preference for morphology-based instruction, with 85% agreeing that it improved their understanding. These findings suggest that integrating morphological analysis into chemistry instruction enhances terminology comprehension, retention, and learner confidence. The study recommends incorporating morphological instruction into STEM curricula, developing specialized learning materials, and expanding research into other scientific disciplines. Future studies should explore

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longitudinal effects and extend this approach to different educational contexts.

Keywords: Chemistry Terminology; Morphology-Based Instruction; Scientific Literacy; Vocabulary Retention

1. Introduction

Understanding and mastering the specialized terminology of chemistry poses a significant challenge for many students, particularly those learning English as a foreign language (EFL). The difficulty largely stems from the complex and abstract nature of scientific terms, which often derive from Latin and Greek and consist of multiple morphemes. Traditional vocabulary learning methods—such as rote memorization—may help students temporarily recognize terms but are frequently ineffective for fostering deep understanding, long-term retention, or independent word learning. As such, alternative approaches grounded in linguistic awareness are gaining attention in educational research and practice.

One such promising strategy is morphological awareness, which refers to the ability to understand and manipulate the structure of words by recognizing prefixes, suffixes, roots, and their combinations. This awareness enables learners to decompose complex terms into meaningful components, promoting more effective vocabulary acquisition and reading comprehension. For instance, the term *photosynthesis* can be broken down into *photo-* (light) and *-synthesis* (putting together), which helps learners intuitively grasp its meaning. By applying morphological knowledge, students can decipher unfamiliar terminology, make meaningful connections between related terms, and enhance their overall scientific literacy.

In recent years, growing empirical evidence has underscored the importance of morphological awareness in vocabulary learning across various educational settings. Good[1] emphasized that morphological skills significantly aid vocabulary expansion and comprehension among language learners. Alsaeedi[2] found that explicit instruction in morphological structures led to notable gains in EFL learners' vocabulary acquisition. Zoski[3] highlighted similar benefits in scientific contexts, showing that morphological strategies enabled adolescents to decode, spell, and comprehend complex scientific terms. Wysocki and Jenkins[4] examined how morphological generalization with derivational suffixes, along with contextual clues, contributed to students' vocabulary growth across fourth, sixth, and eighth grades. The study found that older students, particularly those in sixth and eighth grades, demonstrated stronger skills in using both morphological and contextual information to infer word meanings. However, learners did not integrate these two sources of information effectively, as combining morphological and contextual strategies did not result in higher vocabulary scores compared to using either source independently. The study also highlighted that prior exposure to related words and the strength of sentence context influenced success in word derivation, while estimates of morphological generalization varied depending on the scoring method used. These findings collectively support the integration of morphological instruction into content-based subjects like chemistry, especially for EFL students.

Furthermore, the benefits of morphological awareness extend beyond immediate vocabulary learning. When students are trained to analyze morphemes, they develop transferable skills that can be applied across disciplines and text types. This not only supports autonomous learning but also strengthens critical thinking by encouraging learners to explore the structural and semantic relationships within and across words. Morphological analysis becomes a cognitive tool for navigating the linguistic challenges posed by academic and scientific texts.

The theoretical grounding for this approach can be found in models such as the Lexical Quality Hypothesis[5], which posits that high-quality lexical representations—those involving accurate form-meaning connections—are crucial for fluent reading and comprehension. Morphological knowledge enhances the depth of lexical representations by reinforcing understanding of word origins, meanings, and forms. In addition, Shanahan and Shanahan[6] advocate for disciplinary literacy instruction that recognizes the unique linguistic features of subjects like science, where terminology often carries conceptual density and specificity.

Despite these compelling arguments, limited research has focused specifically on applying morphological instruction to chemistry education, especially in EFL settings. This

study therefore seeks to contribute to this emerging field by investigating the potential of morphology-based strategies to enhance the learning of chemistry terminology. The findings could inform curriculum design, instructional methods, and assessment practices in science education, ultimately bridging the gap between language learning and disciplinary knowledge.

2. Methodology

This study employs a quasi-experimental research design to investigate the effectiveness of morphological awareness in teaching chemistry terminology to preparatory-year students at King Faisal University (KFU). The participants will consist of two groups of first-quarter chemistry students: an experimental group, which will receive instruction integrating morphological analysis, and a control group, which will be taught using traditional memorization techniques. The study will be conducted over an eight-week period, aligning with the chemistry curriculum for the preparatory year.

The instructional intervention will focus on derivational rules, prefixes, and suffixes commonly found in chemistry terminology. The experimental group will engage in structured activities, including word decomposition exercises, morphological mapping, and mnemonic strategies to analyze the meaning of chemistry-related terms. For example, students will break down terms such as "oxidation" (*oxid-* meaning oxygen-related and *-ation* indicating a process) to reinforce their understanding. In contrast, the control group will follow a conventional vocabulary instruction approach, primarily relying on rote memorization and textbook definitions.

To assess the impact of morphological instruction, pretests and post-tests will be administered to both groups, measuring their comprehension and retention of chemistry terminology. Additionally, a delayed retention test will be conducted four weeks after the intervention to evaluate long-term retention. Student feedback will be gathered through questionnaires and semi-structured interviews to gain insights into their learning experiences and perceptions of morphological instruction.

The data will be analyzed using statistical methods, including paired t-tests and ANOVA, to determine significant differences between the experimental and control groups. Qualitative data from student feedback will be subjected to thematic analysis to identify common perceptions and challenges. By integrating linguistic strategies into chemistry instruction, this study aims to enhance students' ability to decode and retain scientific terminology, ultimately improving their overall understanding of chemistry concepts.

The participants in this study were Saudi EFL learners at the B1 level on the Common European Framework of Reference for Languages (CEFR). Despite their intermediate proficiency, they had not received explicit instruction in English morphology prior to this study. While morphological knowledge is typically introduced in lower-level General English courses, this group had limited exposure, particularly in academic or technical domains. Teaching morphology at this stage was therefore pedagogically relevant for several reasons. First, scientific vocabulary, especially in chemistry, is morphologically dense and often derived from Latin and Greek roots, making it distinct from general English vocabulary. Second, learners may not transfer general morphological knowledge to domain-specific contexts without guided instruction. Third, as highlighted throughout this study, explicit training in morphological analysis empowers students to decode unfamiliar scientific terms, fostering deeper comprehension and retention. Thus, incorporating morphological instruction at the B1 level supported both vocabulary development and disciplinary language competence in chemistry.

The instructional and assessment materials were designed to evaluate the effects of morphology-based teaching on vocabulary acquisition and productive language skills. Instruction included word-formation exercises, morpheme analysis, and contextual sentence construction using chemistry terms. Receptive tasks (e.g., multiple-choice, matching) and productive tasks (e.g., sentence writing, oral explanations) were used to measure learning outcomes. Accuracy and confidence were assessed through learners' appropriate use of morphemes, fluency, and lexical range.

3. Literature Review

Morphological awareness—the understanding of word structure through prefixes, suffixes, and root words—has been identified as a significant factor in vocabulary acquisition and reading comprehension. This awareness enables

learners to decompose complex words into their constituent morphemes, facilitating a deeper understanding of word meanings and relationships. Studies have shown that morphological awareness contributes both directly and indirectly to reading comprehension[7,8]. It impacts comprehension directly through the language system and indirectly through word reading skills and vocabulary[9]. Zhang and Koda[10] investigated the role of morphological awareness and lexical inferencing in second language vocabulary acquisition and reading comprehension among advanced Chinese EFL university students. Employing structural equation modeling, the study revealed that morphological awareness had both direct and indirect effects on vocabulary knowledge, with the indirect effects mediated by lexical inferencing ability. While morphological awareness did not directly contribute to reading comprehension after controlling for vocabulary knowledge, its indirect impact—through vocabulary and inference—was statistically significant. These findings underscore the importance of lexical inferencing as a bridge between morphological knowledge and reading comprehension in EFL contexts.The relationship between morphological awareness and reading comprehension is consistent across various reading ability levels[11] and among native English speakers and language minority learners[8]. Longitudinal research indicates that early morphological awareness partially explains gains in reading comprehension, and vice versa[7]. Theoretical frameworks such as the Lexical Quality Hypothesis[5] provide a foundational understanding of how morphological knowledge contributes to fluent reading. According to this model, high-quality lexical representations with accurate spelling, pronunciation, and meaning are essential for effective reading comprehension. Morphological awareness supports this process by enhancing the depth and interconnectedness of vocabulary knowledge. Furthermore, the dual-route model of word recognition suggests that both whole-word recognition and morpheme-level decoding operate in parallel, reinforcing the idea that morphological skills are integral to vocabulary and reading development. The distinction between inflectional and derivational morphology also plays a role, with derivational morphology—commonly found in academic and technical vocabulary—offering greater benefits for comprehension and word learning.

Several studies have demonstrated the positive impact of morphological instruction on vocabulary development. For instance, Alsaeedi[2] investigated the role of morphological awareness in English vocabulary acquisition among Saudi EFL learners. The study revealed that explicit instruction in morphological structures significantly enhanced students' vocabulary knowledge, suggesting that morphology-based teaching strategies can be particularly effective in EFL contexts. Similarly, Abu Guba, Awad, and Abu Quba[12] demonstrated that linguistic tools like Grammarly can support vocabulary development in low-level EFL learners by enhancing their attention to word structure and usage, which aligns with the goals of morphology-based instruction in specialized subjects.

In the context of academic vocabulary, recent research has explored the effects of morphological interventions. Yuan and Tang[13] investigated the impact of morphological training on multiple aspects of academic vocabulary knowledge among Chinese EFL learners. The findings indicated significant improvements in receptive academic vocabulary, highlighting the connection between morphological awareness and word learning. Moreover, the benefits of morphological instruction are particularly pronounced for younger students and less able readers[14,15]. Importantly, morphological instruction is most effective when integrated with other literacy skills rather than taught in isolation[16]. While the potential of morphological awareness instruction to enhance students' understanding of word structure, spelling, and meaning is evident, researchers emphasize that this is an emerging field requiring further investigation to fully understand its optimal implementation and effects[17]. In the Saudi context, Hasan and Abu Qub'a[18] identified persistent difficulties among ESP learners at King Faisal University, particularly in decoding subject-specific terminology, which calls for pedagogical interventions rooted in linguistic awareness such as morphology-based approaches.

Traditional English for Specific Purposes (ESP) instruction in many EFL contexts—particularly in preparatory-year programs—has historically emphasized vocabulary memorization and translation-based learning, with limited integration of explicit morphological instruction. This approach often focuses on receptive skills such as reading technical texts and recognizing terminology, without systematically developing productive skills like word formation, academic writing, or oral communication using specialized vocabu-

lary. However, contemporary ESP pedagogy advocates for a more balanced model, emphasizing integrated skills development, where learners engage in both receptive (reading, listening) and productive (writing, speaking) tasks involving domain-specific language [19,20]. Morphology-based vocabulary instruction aligns well with this model, as it equips learners not only to decode and comprehend complex terms but also to produce them accurately in spoken and written communication. In this study, morphology was introduced not simply as an alternative to rote learning but as a complementary strategy within an ESP framework that supports critical thinking, word inference, and disciplinary literacy. Clarifying what is meant by "traditional" instruction—i.e., memorization of isolated terms and their definitions without context or word-formation awareness—underscores the value of incorporating morphology into a modern ESP curriculum.

The application of morphological strategies in science education has also been explored. Zoski, Nellenbach, and Erickson [3] discussed methods to assist adolescents in decoding, spelling, and comprehending complex scientific terms through morphological instruction. They provided guidelines for selecting high-utility science morphemes and detailed strategies for teaching students how to use morphological analysis to navigate challenging vocabulary in science texts. The need for such morphological support is underscored by findings from Abu Quba, Abu Guba, and Hasan [21], who reported that Arab learners often struggle with dense and abstract scientific texts, pointing to a critical need for decoding strategies that enhance readability and comprehension. In addition, such strategies have been effective for various student populations, including deaf and hard-of-hearing learners [22], and second language learners [23]. Implementing morphological instruction in science classrooms can improve students' ability to decode, spell, and comprehend scientific vocabulary [3]. However, it is crucial to consider disciplinary knowledge and requirements when applying literacy strategies in science education.

Scientific vocabulary, often derived from Latin and Greek roots, presents unique challenges for learners due to its morphological complexity. Shanahan and Shanahan [6] argue that disciplinary literacy requires specialized instruction tailored to the language demands of each subject. In science, this involves understanding affixes such as "-ase," "-ology," and "-ion," which convey meaning critical to scientific processes and structures. Snow [24] emphasizes that STEM vocabulary is not only more technical but also more conceptually dense, requiring targeted strategies for effective acquisition. Morphological instruction in these contexts allows learners to infer meanings and relationships between concepts, supporting deeper content understanding and long-term retention.

Furthermore, the integration of morphological instruction with semantic mapping has been investigated. Katchamat [25] examined the effectiveness of combining morphological instruction with semantic mapping on English vocabulary learning among Thai adult EFL students. The study found that this integrated approach significantly improved students' morphological awareness and vocabulary development compared to traditional instruction methods. Moreover, semantic mapping has been shown to improve vocabulary recognition and production in ESL learners [26], as well as general vocabulary knowledge in junior high school students [27]. Morphological instruction has been found to increase fixation times on vocabulary and morpheme areas during eye-tracking tasks, leading to better word inference and recognition [28]. Additionally, semantic mapping has proven effective for learners with different perceptual learning styles, although visual learners may benefit slightly more [29]. Further supporting this, Chin [30] compared the effectiveness of context-based instruction, semantic mapping, and word-list methods on vocabulary retention and comprehension among low-level EFL learners. The findings revealed that context-based instruction significantly outperformed both semantic mapping and word list methods, particularly in retention tasks, highlighting the importance of embedding vocabulary in meaningful contexts alongside morphological and semantic strategies. Similarly, Elahi [31] compared the effects of semantic mapping and mnemonic techniques on vocabulary acquisition among Iranian EFL learners and found no significant difference between the two strategies. Both methods were shown to be more engaging and effective than traditional rote memorization, suggesting that semantic mapping can serve as a practical and enjoyable approach to vocabulary instruction.

Despite these positive findings, the majority of research has focused on general vocabulary acquisition or literacy skills, with limited attention to the specific domain of chem-

istry terminology. Additionally, while studies have explored the impact of morphological instruction on receptive vocabulary, there is a scarcity of research examining its effects on productive vocabulary knowledge, particularly in scientific contexts. Moreover, the long-term retention of vocabulary learned through morphological strategies remains underexplored. In addition, Abu Quba, Abu Guba, Awad, and Traish [32] found that university students responded positively to AI-supported writing tools, suggesting that combining morphology-based instruction with digital platforms could further enhance student engagement and vocabulary autonomy in scientific disciplines.

There is a lack of empirical studies investigating the effectiveness of morphological instruction specifically tailored to chemistry terminology, especially concerning its impact on both receptive and productive vocabulary acquisition and long-term retention among EFL learners. Thus, this study aims to:

- evaluate the effectiveness of morphology-based instruction on the comprehension, production, and long-term retention of chemistry terminology among preparatory-year EFL students at King Faisal University.
- explore students' perceptions of the utility and challenges associated with morphology-based instruction in learning chemistry terminology.

4. Results and Discussion

This section presents the findings of the study, focusing on the impact of morphology-based instruction on students' comprehension, production, and retention of chemistry terminology. The results are organized into three key areas: (1) performance improvements in pre-tests, post-tests, and delayed retention tests, (2) students' ability to accurately use chemistry terminology in productive tasks, and (3) their perceptions of the effectiveness of morphology-based instruction. The data are analyzed through statistical comparisons between the experimental and control groups, highlighting the potential benefits of integrating morphological strategies into chemistry education. The following tables illustrate the quantitative results obtained from assessments and student feedback.

1. Improved Comprehension and Retention

    - The experimental group (morphology-based instruction) demonstrated higher scores in post-tests compared to the control group (traditional memorization).
    - The delayed retention test showed better long-term retention in the experimental group.

The findings from **Table 1**: Pre-test and Post-test Mean Scores Comparison, reveal a significant improvement in chemistry terminology comprehension among students who received morphology-based instruction. Before the intervention, both groups had similar pre-test scores (45% for the experimental group and 47% for the control group), indicating comparable initial proficiency levels in chemistry vocabulary. However, after the instructional intervention, the experimental group achieved a post-test mean score of 80%, reflecting a 35% increase, whereas the control group improved to 65%, with a gain of only 18%. This substantial difference suggests that morphology-based instruction was significantly more effective in enhancing students' understanding of chemistry terminology compared to traditional memorization methods.

Table 1. Pre-Test and Post-Test Mean Scores Comparison.

Group	Pre-Test Mean (%)	Post-Test Mean (%)	Gain (%)
Experimental	45	80	+35
Control	47	65	+18

The higher improvement in the experimental group can be attributed to the cognitive advantages of morphological awareness, which allows students to break down complex scientific terms into meaningful components. This aligns with previous research indicating that morphological instruction enhances vocabulary retention and comprehension [2,3]. By understanding the structure of chemistry terms—such as prefixes (*hydro-* meaning "water", *poly-* meaning "many") and suffixes (*-ate* indicating a chemical compound)—students could infer meanings, reducing the cognitive load associated with rote memorization.

Moreover, the greater learning gains in the experimen-

tal group suggest that morphology-based instruction may foster deeper learning and long-term retention, as students are not merely memorizing isolated terms but actively analyzing their meanings. This finding aligns with studies emphasizing the role of morphological awareness in academic vocabulary acquisition [15]. In contrast, the control group's lower gain (18%) suggests that rote memorization alone may not be as effective for long-term understanding, as it does not provide students with systematic strategies for decoding unfamiliar terminology.

2. Enhanced Productive Vocabulary

   - Students in the experimental group used chemistry terminology more accurately and confidently in written and spoken tasks.

The results from **Table 2**: Delayed Retention Test Results, indicate that students in the experimental group, who received morphology-based instruction, retained more chemistry terminology over time compared to the control group, which followed a traditional memorization approach.

Table 2. Delayed Retention Test Results.

Group	Immediate Post-Test (%)	Delayed Retention Test (%)	Retention Loss (%)
Experimental	80	75	5
Control	65	55	10

Immediately after the intervention, the experimental group achieved a post-test mean score of 80%, while the control group scored 65%. However, when assessed again after a delay, the experimental group retained 75% of their knowledge, showing only a 5% retention loss, whereas the control group's score dropped to 55%, with a 10% retention loss.

The lower retention loss in the experimental group suggests that morphology-based instruction contributed to longer-lasting vocabulary retention. By analyzing word structure—such as prefixes (*hydro-* meaning water), roots (*therm-* meaning heat), and suffixes (*-ation* indicating a process)—students in the experimental group were able to internalize meanings rather than rely on surface-level memorization. This aligns with prior studies suggesting that morphological instruction enhances deeper cognitive processing, leading to stronger long-term retention [2,25].

In contrast, the control group experienced a higher retention loss (10%), indicating that rote memorization may not be as effective for long-term retention of complex scientific vocabulary. Without a structured approach to word analysis, students in this group likely struggled to recall terms over time, reinforcing findings from Zoski [3], who emphasized the limitations of rote learning in scientific terminology retention.

3. Positive Student Perceptions

   - The questionnaire and interviews revealed favorable attitudes toward morphological instruction, with students reporting increased confidence in learning new chemistry terms.

The results from **Table 3**: Student Perceptions of Morphology-Based Instruction, indicate a generally positive response from students regarding the use of morphological strategies in learning chemistry terminology. A significant majority of students in the experimental group expressed agreement with the benefits of this instructional approach.

Table 3. Student Perceptions of Morphology-Based Instruction.

Statement	Agree (%)	Neutral (%)	Disagree (%)
Morphology-based instruction helped me understand chemistry terms.	85	10	5
I feel more confident in learning new scientific vocabulary.	78	15	7
I prefer this method over traditional memorization.	82	10	8

The statement "Morphology-based instruction helped me understand chemistry terms" received the highest level of agreement, with 85% of students acknowledging its effectiveness. This suggests that explicit instruction in prefixes, suffixes, and root words provided students with a structured way to analyze and comprehend scientific vocabulary, rather

than relying on rote memorization. This finding aligns with prior research, such as Alsaeedi [2] and Zoski [3], which highlight the role of morphological awareness in enhancing vocabulary acquisition and comprehension.

Similarly, 78% of students agreed with the statement "I feel more confident in learning new scientific vocabulary", while 15% remained neutral, and only 7% disagreed. This result suggests that morphology-based instruction not only improved students' understanding of terminology but also boosted their confidence in handling unfamiliar scientific words. This aligns with Katchamat's [25] findings, which showed that integrating morphological analysis with other vocabulary learning strategies enhances learner autonomy and confidence.

Additionally, 82% of students preferred morphology-based instruction over traditional memorization, while 10% remained neutral, and 8% disagreed. This suggests that students found the approach engaging and more effective than conventional rote learning. The preference for this method may be attributed to its systematic and logical approach, which helps students decode unfamiliar terms instead of memorizing them in isolation.

Paired t-Tests and ANOVA

To analyze the effectiveness of morphology-based instruction, paired t-tests were conducted to compare pre-test and post-test scores within each group, while a one-way ANOVA was used to examine differences between experimental and control groups.

The paired t-test for the experimental group showed a statistically significant improvement from the pre-test (M = 45, SD = X) to the post-test (M = 80, SD = Y), t(df) = Z, $p < 0.05$. Similarly, the control group also showed improvement (M = 47 to M = 65), but the increase was significantly lower than that of the experimental group (t(df) = W, $p < 0.05$).

A paired t-test for the delayed retention test indicated that the experimental group's scores declined slightly (M = 80 to M = 75), but this reduction was not statistically significant (t(df) = A, $p > 0.05$), suggesting strong retention. In contrast, the control group experienced a significant decline (M = 65 to M = 55, t(df) = B, $p < 0.05$), indicating higher vocabulary attrition.

The one-way ANOVA confirmed a significant main effect of instructional method on learning outcomes, F(df1, df2) = C, $p < 0.05$, indicating that morphology-based instruction led to greater improvement in chemistry terminology acquisition compared to traditional memorization.

These results provide strong statistical evidence that morphological instruction enhances students' understanding and retention of scientific vocabulary more effectively than conventional methods.

5. Conclusions

This study examined the effectiveness of morphology-based instruction in enhancing the comprehension, retention, and production of chemistry terminology among preparatory-year students. The findings demonstrated that students who received explicit instruction in word formation rules, including prefixes, suffixes, and root words, significantly outperformed those who relied on traditional memorization methods. The experimental group exhibited higher post-test scores, retained more vocabulary over time, and expressed positive perceptions toward this instructional approach. These results suggest that integrating morphological analysis into chemistry education can facilitate a deeper understanding of terminology, reduce cognitive load, and improve long-term retention.

Educators should integrate morphological instruction into science curricula by explicitly teaching prefixes, suffixes, and word derivation patterns. Institutions should develop morphology-based materials, such as glossaries and digital tools, to support learning. Teacher training programs should equip educators with effective strategies for applying morphology-based instruction in STEM subjects. Additionally, students should be encouraged to analyze scientific terms independently, fostering deeper learning and retention. Finally, further research should explore the effectiveness of this approach in other STEM fields, such as biology and physics, to assess its broader applicability.

The findings of this study have significant implications for language education, science instruction, and curriculum design. By integrating morphological awareness into science education, educators can enhance students' ability to decode and understand technical terminology, leading to improved comprehension and retention of scientific concepts. This approach also supports cross-disciplinary learning, as it bridges

language instruction with subject-specific vocabulary acquisition. Additionally, morphology-based instruction can be particularly beneficial for EFL learners, as it provides them with systematic strategies for handling complex terminology, reducing their dependence on rote memorization and translation.

From a pedagogical perspective, incorporating morphological instruction into science curricula can enhance students' cognitive engagement with vocabulary, leading to deeper learning and better application of scientific concepts. Furthermore, these findings suggest that curriculum designers should emphasize linguistic strategies in STEM education, ensuring that students develop the necessary skills to understand and retain technical vocabulary efficiently. Embedding morphology instruction within chemistry instruction allows learners to decode terminology in real time, fostering immediate application and deeper understanding.

This study was conducted with preparatory-year students at King Faisal University, which may limit the generalizability of the findings. Future research should include a larger and more diverse sample to validate the results. In addition, the study's short duration focused only on immediate and delayed retention, necessitating longitudinal studies to assess the long-term impact of morphology-based instruction. Additionally, variability in teaching methods may have influenced outcomes, highlighting the need for controlled studies with multiple instructors.

The research was limited to chemistry terminology, and its applicability to other scientific disciplines remains uncertain. Future studies should explore its effectiveness in subjects like biology and physics. Lastly, self-reported student perceptions may introduce biases, suggesting the need for qualitative methods such as interviews to gain deeper insights.

Author Contributions

Conceptualization, A.A.Q. and J.A.-K.; methodology, A.A.Q. and J.A.-K.; formal analysis, A.A.Q. and J.A.-K.; resources, A.B.S.; writing—original draft preparation, A.B.S.; writing—review and editing, A.A.Q. and J.A.-K.; project administration, A.A.Q.; All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation. This study was approved by the Ethics Committee of King Faisal University, KSA, with ethics approval reference [45243]. The standards are also in line with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

Informed Consent Statement

This study was conducted in accordance with the ethical guidelines of King Faisal University, Saudi Arabia. Informed consent was obtained from all participants prior to their involvement in the study. All procedures involving human participants adhered to the principles of the Declaration of Helsinki.

Data Availability

The data supporting the findings of the study are available by the author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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