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Unraveling Vocabulary Ambiguity: Contextual Lexis Learning and Vocabulary Retention for ESP Learners

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ABSTRACT

Ambiguity of meaning exists in every language and at all levels of linguistic structure. A common feature of English for Specific Purposes (ESP) texts is the ambiguity of meaning in the teaching and learning of ESP. Vocabulary retention is another problematic issue for learners at all levels in every language. For ESP students, Contextual Lexis Learning (CLL) is beneficial, since it has a decisive impact on establishing meaning and retaining vocabulary. The current study aims to investigate the effectiveness of CLL in helping ESP students understand the meaning of vocabulary and retain it. The study involved 50 undergraduate students enrolled in an engineering program, who were assigned to either the experimental group or the control group. Before the training, a pre-test was conducted to determine their levels of proficiency. Post-tests were performed under different conditions after every two training sessions. The results of the T-test and Independent Samples T-test indicate that CLL has a significant and wide-ranging effect on students' ability to comprehend and produce vocabulary in various situations, as well as to retain it in both the short and long term. The current study demonstrates that CLL methods enhance students' confidence and autonomy, reducing their reliance on dictionaries and external resources. This article has some curriculum design and pedagogical implications, suggesting that if we equip our students with improved vocabulary proficiency and a greater understanding of language, we must make CLL a component of any ESP program.

Keywords: Ambiguity of Meaning; Contextual Meaning; Vocabulary Retention; ESP; Contextual Lexis Learning

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1. Introduction

Specialized vocabulary and retention in ESP play a crucial role in the understanding of technical texts by non-expert readers through the acquisition and use of technical language [1–3]. In ESP, this specialized vocabulary is essential because it enables learners to interact effectively within their field of work. However, traditional approaches to ESP have not been sufficient to fully close the gap between general and specialized knowledge when it comes to making technical vocabulary more applicable to a specific field, such as "actuator" in Mechanical Engineering disciplines or "free on board" in Business [4].

Moreover, reading has also been found to support both retention and disambiguation of vocabulary [5], and retention and deciphering of meaning are closely related to reading comprehension. It has been shown that not only is the size of vocabulary knowledge related to reading performance [6], but also the depth of vocabulary knowledge, which refers to a person's understanding of the various aspects of words, including their context and nuances.

To address these challenges, facilitating the overcoming of all the challenges and limitations of traditional methods and various contemporary educational technologies in the domain of ESP, such as interactive learning systems and customized instruction, could increase engagement and adaptability [7]. In addition, specialized lexicons, which minimize ambiguity and enhance reading, are critical in enabling non-experts to access and understand technical writing [8].

Furthermore, the global trend of internationalization in higher education has heightened the demand for ESP courses that address both academic and occupational needs, highlighting the significance of specialized vocabulary in academic and professional contexts [9].Therefore, a diverse strategy, ranging from conventional to modern variable learning, and a shift in both the size and depth of word complexity, based on a comprehensive reading of technical materials within a working context, should become a core goal of ESP [7,10]. In an era where knowledge is tailored to disciplines and careers are carved through the corridors of specialization, the mastery and retention of specialized vocabulary in ESP emerges not as a linguistic luxury but as a pedagogical imperative—an indispensable key that unlocks the nuanced meanings of technical texts, bridging the chasm between comprehension and professional application for non-expert readers navigating domain-specific discourse. Thus, the crucial need for specialist vocabulary and retention in ESP is to bridge the gap between general and technical language, and it also calls for current, varied methods to improve understanding and use in the workplace.

In specialized domains, lexical ambiguity poses significant challenges to professional communication, given the specialized meanings of words within narrower domains. This complicated matter is not just for specialists and their non-specialist interlocutors; it also affects colleagues from other specialty areas or cultures. Indeed, mismatches between definitions can contribute to miscommunication between specialists and laypeople and communication across fields [11]. For example, words commonly used in everyday conversation suddenly acquire specific meanings in professional discourse. Lexical ambiguity is further complicated by homonyms and polysemy, where words have different meanings depending on the context, which must be disambiguated for accurate understanding [12]. In technical and scientific translation, there are also 'false friends', where a term looks similar to a term in another language but has an entirely different meaning, creating barriers between translators who need to be careful with these terms in order to provide clear and precise communication [13].

In addition, terminological ambiguity due to different understandings of words from various fields or cultures contributes to difficulties in collaborative interaction in multidisciplinary and multinational research projects that require mutual understanding among individuals through active communication [14]. Although contextualized language modeling has exhibited potential in understanding nuanced differences among polysemes or comparable words based on psychological theories [9], it remains insufficient for fully resolving ambiguity. This, however, could not be adequately addressed and even led to the unsuccessful disentangling of meanings among similar words. Specifically, in healthcare, so-called "tortured phrases" are vague and obscure terms that replace standard jargon.

Moreover, in 2017, a "disjointed" language began to emerge in the field, resulting in skewed communication and sloppy decisions, as well as misinterpretations and mistakes in complicated clinical situations [15]. Therefore, to overcome these challenges, it is essential to develop more advanced natural language processing systems that can effectively address lexical ambiguities and adopt strategies to standardize terminology across different languages and fields of study [16]. These unintended meanings have a sequence of implications, as terms that require more detailed explanation must be clearly defined, and various measures must be taken to ensure that communication itself does not lead to misunderstandings.

Context is multifaceted and thus has a dual effect on vocabulary acquisition and retention, affecting both meaning disambiguation and learning efficacy. This duality is evidenced by studies that show how contextual factors profoundly influence how learners encode and store new vocabulary. For instance, encountering the same vocabulary multiple times in the same speech can enhance short-term learning and processing speed, but at the risk of reducing long-term word retention [17]. Similarly, although contextual diversity slows down the processes of encoding and integrating new meanings, it does not lead to more excellent vocabulary gains [18]. Consequently, this highlights the importance of the semantic richness of the context, with more informative contexts being more successful in conveying the intended meanings and facilitating better retention of the words' meanings [19]. Furthermore, the emotional valence of context also influences retention; an emotionally loaded context, especially a negative one, enhances the retention of vocabulary [20]. Moreover, consistent contextual meaning between learning sessions facilitates recall and retention better than inconsistent contexts, which can cause confusion and inhibit recall [21].

It is a process of disambiguation, which means determining the specific meaning of a word based on its context, used to understand speech and language, as words can have multiple meanings [22]. Moreover, the context used in e-learning ecosystems, such as virtual reality environments, enhances users' motivation and strategy use, which can lead to increased vocabulary learning [23]. Readings are not only for understanding vocabulary and concepts related to the text; they can also assist native speakers and learners of a second language with contextual learning strategies, such as inferring the meaning of words from context [24]. Notably, even if context enhances comprehension, retrieval practice in less informative contexts may promote more durable retention over time by facilitating the retrieval of what was learned [25]. On the one hand, context can serve as a storehouse of available knowledge. On the other hand, context can also act as an activator of knowledge, selectively influencing the way we construct and understand meaning, especially in multilingual situations where the situational context may not be uniform [26]. Context operates as both a compass and canvas in vocabulary acquisition—guiding meaning through semantic cues while shaping retention through emotional and situational resonance. Though rich, consistent contexts enhance disambiguation and memory, especially in emotionally charged or immersive environments, it is often the interplay between contextual depth and strategic retrieval in varied settings that secures lasting lexical mastery.

1.1. Research Gap

Existing research on vocabulary ambiguity in ESP courses, particularly in the engineering subfield, reveals several gaps that require addressing. A significant gap exists: the mismatch between the language needs of engineering students and the existing ESP curriculum. Example programs, such as the "Business English and Soft Skills" course at the ENSEM Engineering School, do not account for specialized technical terminology and communicative genres relevant to mechanical engineering students, highlighting the need for an ESP-focused curriculum that emphasizes technical writing and precise communication [27]. Likewise, in Russia, the vocabulary requirements of ESP materials differ across engineering disciplines, with Chemical Engineering requiring the largest comprehension vocabulary size compared to Thermal Power and Computer Engineering [28]. This reveals inconsistency and inadequate vocabulary availability across different Engineering disciplines [29].

In addressing these concerns, corpus linguistics also turns out to be a helpful method for developing special-

ized word lists, such as the example of marine engineering stemming from Tu's work [30], as it supplies students with a more focused selection of vocabulary and thus may address some of the vocabulary issues in the context of engineering studies in the broader sense [31]. Nevertheless, lexical ambiguity remains a challenge; research on natural language requirements and contextual language models demonstrates that a polysemous word's lexical ambiguity can weaken comprehension and efficient communication [32]. Such vagueness and, in some cases, contention in terminology only add to the confusion, which can result in misunderstandings and ineffective pedagogy [28].

Compounding these problems, the misconception that academic vocabulary does not change between disciplines surprisingly makes it even harder to teach students words that they will need for their studies and in professional settings, thereby encouraging students to engage themselves in self-learned discovery exercises to get a sense of the words and phrases commonly used in their respective fields [33]. Finally, a needs analysis in Bangladesh reveals a lack of ESP programs that focus on technical terminology and communication skills, indicating that existing curricula are inadequately equipped to equip students with the essential knowledge and skills required to meet industry standards and prepare them for real-world applications [34]. As a collective contribution, these findings demonstrate the necessity of more specialized, discipline-oriented ESP courses that specifically target the use of ambiguous vocabulary and prepare engineering students with the required linguistic skills required for their professions.

Previous studies on retention strategies for ESP vocabulary have highlighted various shortcomings that inform vocabulary acquisition and retention for students. Nguyen and Hoang argue that there is also a growing gap in the effective practice of vocabulary acquisition strategies [35]. This issue gets to the heart of the issue by highlighting challenges, including limited exposure to ESP terminology and insufficient opportunities to apply it in practice, leading to retention issues in Vietnamese non-English majors and, therefore, a need for tailored teaching strategies and curriculum adjustments [36]. According to Duong's study, although metacognitive strategies are often utilized, social (consolidation) strategies are not, suggesting a lack of VLS (vocabulary learning strategies) [37]. The study by Tran and Do on vocabulary notebooks reveals their potential for enhancing vocabulary retention, while also emphasizing the need for explicit instruction and scaffolding to ensure their effectiveness [38]. Furthermore, recognizing the need for effective strategies to enhance vocabulary mastery in vocational education, it is noted that existing approaches may not adequately address the diverse needs of learners [39].

Together, these studies underscore the need for more holistic, context-specific strategies and resources to effectively facilitate the retention of ESP vocabulary, offering solutions to both pedagogical and practical challenges. Retention of ESP vocabulary remains a fragile pursuit, often undermined by limited exposure, insufficient application, and underused learning strategies, revealing a widening gap between pedagogical theory and classroom reality. While studies call for explicit instruction, contextualized scaffolding, and diversified strategies tailored to learners' vocational needs, the path forward lies in crafting holistic, practice-driven approaches that embed vocabulary within meaningful use, ensuring lasting mastery rather than fleeting familiarity.

The ESP curriculum for Bangladeshi engineering students remains inadequate because it fails to provide them with the necessary language and professional skills for their jobs. Students in Civil Engineering and Electrical and Electronics Engineering (EEE) frequently lack systematic training in academic writing, oral communication, and technical vocabulary [34]. The situation is similar in Mechanical Engineering: although technical terminology and the writing of SOPs and technical reports are seen as important, conversational and oral communication skills are mostly overlooked [40].

Bangladesh urgently requires a contextual vocabulary learning framework that combines language skills with domain-specific skills. This is because global communication and mastery of specialized information are necessary for professional success [41]. Some institutions, like ENSEM Engineering School, nevertheless put commercial communication and soft skills ahead of the precise engineering terminology and genre-specific discourse that the field needs [27].

The situation worsens when ESP training is still limited to textbooks, which are stiff and do not encourage participation. The way forward calls for a responsive, flexible curriculum—one that combines the best parts of traditional teaching with the newest technologies in education. This will help Bangladesh's future engineers get ready for the competitive global market by putting vocabulary in real-world situations [7]. Research on retention in English for Specific Purposes (ESP) vocabulary, particularly concerning short-term versus long-term outcomes in Bangladesh, appears to be underexplored [34,41].

This study aims to address the retention problems of ESP students who use traditional methods for vocabulary learning. By incorporating CLL, students can overcome confusion about identifying and deciphering the real meaning of ESP words within their contexts.

1.2. Objectives of the Study

The objectives of this study are to investigate the impact of contextual lexis learning on short-term and long-term vocabulary retention, as well as its effectiveness in retaining ESP vocabulary within its context. Another important objective of the study is to find which strategies and clues are effective in deciphering the contextual meanings from their ambiguity**.**

1.3. Research Questions

Based on the study's objectives, the following research questions were formulated.

1. *What is the impact of CLL on short-term and long-term vocabulary retention for ESP learners?*
2. *How do contextual lexis learning approaches address ambiguity?*

1.4. Significance of the Study

In essence, the study's significance extends beyond revealing a new perspective on vocabulary acquisition research; instead, it may provide a means to link theoretical research to the practicalities of teaching and curriculum development in ESP. The study is particularly relevant to the area of institutionalized language instruction, as it emphasizes tailored contextual lexis learning approaches that meet the specific lexical needs of ESP learners needing domain-specific lexicons for professional or academic purposes. It highlights task-based and corpus-driven approaches that encourage the use of real-world, contextually relevant language for more effective learning and vocabulary application.

The study not only has theoretical implications, as it deepens understanding of how vocabulary is developed in a specific area, but it also has practical implications by providing examples of how to develop specific vocabulary. It explores the use of collocations, phrases, and lexical thresholds to boost fluency, comprehension, and learner confidence. The results of the study suggest that adjusting cognitive load in ESP learners elevates the notion of vocabulary acquisition to a new level by leveraging digital tools, such as AI and corpus software, to personalize learning and stimulate engagement. This research resolves the problem of ambiguity in vocabulary usage, which supports the development of more effective ESP curricula for teachers and developers, ultimately benefiting learners. These findings pave the way for more firmly established best practices in ESP education while deepening the understanding of how tailored learning approaches help students achieve long-term retention and implement relevant vocabulary.

2. Literature Review

Innovative and strategic learning methods significantly influence the relationship between vocabulary acquisition strategies employed by language learners and the long-term retention of vocabulary. According to constructivist theory, one of the most effective ways to learn new words is when students acquire their meanings of new words by using them in different contexts or by elaborating their meaning in the most semantic ways, which is also referred to as deep processing [42]. In the same vein, the application of self-regulation and spaced repetition methods has been proven to enhance retention by alleviating cognitive load and encouraging more profound cognitive engagement, both of which are indispensable for effective vocabulary learning [43]. Similarly, incorporating strategies

like the keyword method along with pictorial association and mind mapping has been proven to facilitate the transfer of vocabulary from short-term acquisition to long-term retention among EFL/ESL learners, reinforcing the need for variety in learning strategies to support long-lasting accumulation over time [44]. Furthermore, utilizing metacognitive strategies and performing vocabulary tasks are pivotal, given the correlation between the high-frequency use of these strategies and a significant increase in vocabulary acquisition efficiency, especially in complex contexts such as workplace English [30].

Moreover, given that traditional methods do not guarantee long-term retention, innovative methods like technology-based tools and contextualized learning approaches have been reported to lead to a deeper understanding and engagement in comparison with traditional methods [45]. These studies together highlight that using a diverse range of strategic and innovative approaches to upskill vocabulary acquisition and retention really matters; hence, educators should pay more attention to how they can indeed pave the way for their learners to learn faster.

Several issues require clarification regarding the aforementioned studies on the retention and disambiguation of ESP vocabulary in learning and teaching contexts. One primary reason is the limited access to ESP vocabulary, which negatively impacts the understanding and retention of target vocabulary [46]. Moreover, the incorporation of digital applications in ESP instructional resources is advantageous. However, it can only be effective through continuous teacher training and the establishment of standardized evaluation frameworks that incorporate cultural relevance [47].

Nevertheless, there are also some problems with online tools due to their individualization, as users must cope with the sophistication of specialized lexicons used to accomplish specific communication purposes in their professional areas [48]. On a positive note, generative approaches have, even in some experiments, shown promise in generating effective pedagogical contexts for vocabulary exercises, with zero-shot models (such as Gemini) receiving high scores for their pedagogical usability [49]. To overcome these challenges, educators must implement customized teaching practices that build on students' existing knowledge and skills, motivating self-efforts and peer learning among learners [47]. With these strategies and the proper use of technology as well as contextually appropriate materials, ESP vocabulary can be effectively acquired and suitably utilized in various learning environments.

2.1. Contextual Lexis Learning

Contextualization refers to the different forms of linking a vocabulary item to various types of contexts, namely local, sentential, topical, or global context, in connection with learning lexis. According to Alhama [50], the local context, or the surrounding linguistic environment adjacent to a word, is vital for better understanding and acquiring nouns, as these words have a finite number of senses that apply to a specific context.

Furthermore, another type of context is sentential context (the sentence in which the information appears), where the emotional valence of the sentence can impact retention; words embedded in emotionally charged sentences (in terms of either positive or negative emotion) are better remembered than those situated in neutral contexts [51]. In addition, topical context refers to the consistency of the discussion of a topic across clusters of words, and is visible in the use of semantic maps comprising an array of vocabulary concepts grouped into standard sets, which facilitate recall and retention by promoting an organizational framework [52].

Moving to a broader perspective, the global context encompasses a wider range of discourse and situational contexts, including knowledge of the world and the coherence of discourse. Such context is useful in semantic processing and understanding something since it follows linguistic expectation, thus making reading times faster for predictable content [53]. It is well established that context-based strategies are more effective than rote rehearsal when it comes to retaining our new vocabulary, as context provides an overall more apt environment for achieving our meanings [54].

Moreover, contextual diversity, which can be defined as how a particular word appeared in second language (L2) learners' broader context of use, has been postulated to contribute to better explaining lexical organization in

lexical access than word frequency does [55]. By contextualizing the material offered by the teacher with the numerous variations of context, each student can rely on these different occasions, the lexical network is better supported and more integrated, contributing to better learning results, both in the present and in the long term [48].

Lexis learning uses local, sentential, topical, and global context effects, and is therefore an excellent way to ensure that learners commit their vocabulary knowledge to memory for quick retrieval. Using context, as illustrated in certain pieces of research, is an important characteristic of vocabulary learning because it ties the use of words to processes in the brain and in the environment, and, therefore, encourages more meaningful processing and more stable remembering [56].

In support of this, the use of multimedia and context-specific learning systems proposed by Vargo et al. demonstrates that learners are more likely to engage with vocabulary through different contexts to increase motivation and retention, although this can depend on learner traits and yield different efficiencies [57]. Similarly, fragmented exposure to vocabulary in different contexts facilitates faster processing and transient learning, but this conditionalized repetition is not adapted to extended recognition [58].

Furthermore, contextualized micro-lessons and meaning-recall testing platforms embody the notion that embedding vocabulary in relevant contexts enhances learning outcomes and engagement [59]. Moreover, Ji provides an example from distributional semantic theory that hints at how associating words with varied contexts through techniques such as refresh makes a prominent contribution to vocabulary acquisition, especially in cases of hard-to-learn word categories such as homonyms [60]. Collectively, these findings highlight the significance of attending to diverse levels of contextual input in vocabulary instruction to enhance retention and transfer, thus rendering vocabulary knowledge a more meaningful and powerful tool for learners of language systems [61].

2.2. Vocabulary Ambiguity in ESP Contexts

Vocabulary ambiguity is one of the major factors affecting the comprehension of an ESP course across all fields, as it complicates the interpretation of specialized academic texts. With significant dependency on the reading comprehension in English for Occupational Purposes (EOP), the understanding of core-academic and technical-academic vocabulary was elucidated through a study with Iranian psychology students that showed these types of vocabulary accounted for 92% of the variance in reading scores [59].

Moreover, when it comes to understanding the concepts of the material provided, Lexical ambiguity, which refers to a situation where one word may have multiple meanings, constitutes a further challenge not only in the context of ESP but also in general language understanding more broadly, as it necessitates the disambiguation of multiple potential meanings to arrive at a correct interpretation [62]. In particular, the way of identifying vocabulary for ESP poses a new challenge as learners must distinguish between technical, semi-technical, and general vocabulary that are needed to master ESP material.

Additionally, vocabulary knowledge and non-verbal IQ predict successful comprehension of ambiguous contexts, demonstrating both the cognitive cost of processing ambiguous language and the influence of individual-difference variables on successful comprehension in such contexts [63]. Likewise, by demonstrating the corresponding fuzzy nature of both speech production and comprehension, the previously outlined concepts provide a framework for navigating ambiguity that shapes both what is produced and how it is interpreted, thereby making the provision of specialized, explicit vocabulary from the outset of an ESP course problematic [64]. Therefore, in ESP courses, this will only be reflected in targeted teaching, which must have a greater vocabulary focus on enhancing learners' realization and resolution of vocabulary, thus asking them to understand and apply specialized language.

2.3. Prior Research on Ambiguity Resolution Strategies

There is a remarkable lack of attention given to addressing this issue in the ESP context. Although some studies have investigated the vocabulary learning methods

and problems of ESP learners, few studies have examined whether ESP learners encounter the particular issue of vocabulary ambiguity. Such studies, for example, have investigated the elements of vocabulary related to those in English for Academic Purposes (EAP) textbooks and have shown that while the most attention has been given to grammatical functions and parts of words among the vocabulary, this largely does not include any issues concerning ambiguity [65].

Similarly, research on the teaching of vocabulary in ESP classes focuses on the acquisition of terminological vocabulary and strategies to help improve vocabulary learning without addressing the issue of the meaning of terms [66]. When it comes to the comparative analysis of vocabulary demand, the focus has been primarily on comparing vocabulary demands of different fields relevant to engineering students in Russia, again without addressing the nuanced relationship between vocabulary and comprehension [29].

In addition, previous research on vocabulary learning strategies employed by Vietnamese students and other ESP learners reveals a wide range of strategies used; however, there is limited evidence to show how these strategies alleviate vocabulary ambiguity [37]. Challenges faced by Vietnamese non-English majors in mastering ESP vocabulary are related to problems of comprehension and retention, which can be more challenging due to the vagueness of vocabulary; this has not been the primary focus. In conclusion, while there is considerable research on vocabulary learning strategies and ESP vocabulary difficulties, there remains a significant gap in focused research on tackling the problem of vocabulary ambiguity in ESP courses, indicating an important area for further investigation.

2.4. Synthesis and Gaps

The combined implementation of ambiguity resolution and retention strategies in the specific domain of ESP is a complex issue that remains understudied in the current literature. Ambiguity is an inherent property of language, presenting severe challenges in several areas, including language learning, natural language processing, and requirements engineering. For example, in the context of language learning, especially for non-English majors, those with a high tolerance for ambiguity are more likely to make deliberate reading strategies while reading, and develop better comprehension skills [67].

Moreover, ambiguity continues to be a significant challenge in natural language processing; even state-of-the-art language models such as GPT-4 are still unable to correctly disambiguate sentences according to human judges in a recent evaluation [67]. This suggests the need for more robust, ambiguity-sensitive tools to enhance language model performance and to support and promote language retention in educational contexts. For instance, in requirements engineering, TAPHSIR and Gamify4LexAmb have been used to identify and resolve ambiguities, including anaphoric and lexical ambiguities, respectively, involving users and using machine learning techniques [68]. These tools illustrate the idea of using ambiguity resolution strategies with systems that need a good understanding of the language, which can likely be tweaked for ESP contexts to help further retain language.

Additionally, Lazurko, Haider, and Hertz, et al. highlight examples from sustainability science [69], suggesting that operationalizing ambiguous language through frameworks like Reflexive Boundary Critique is prevalent in the field. Resolving ambiguity rather than embracing it can provide a richer understanding of topics that incorporate and retain complexity. In general, although promising strategies and tools exist to tackle ambiguity, their adoption in ESP remains rare, highlighting a gap that could be addressed through future work aimed at designing comprehensive and blended frameworks that combine clarity-enhancing and retention-enhancing strategies to reshape language learning outcomes.

3. Research Methodology

The study used a mixed-method design to investigate the influence of Contextualized Lexis Learning (CLL) on enhancing vocabulary learning and retention among civil engineering students. First and second semester engineering students were conveniently selected by purposeful sampling of size fifty, who were randomly assigned to the experimental group (CLL; n = 25) and the control group

(conventional vocabulary learning; n = 25). Training sessions using contextually rich engineering materials were systematically organized for the experimental group, while the control group focused on conventional vocabulary learning using word lists and rote memorizing strategies. Before the course started, a pretest was administered to evaluate baseline proficiency, and three posttests were used to examine learning retention of new vocabulary items. The assessment tools demonstrated acceptable reliability, represented with Cronbach's alpha values exceeding 0.80. Data were analyzed in SPSS (Version 25.0). Significance testing was conducted using Independent Samples T-tests and repeated-measures ANOVA with significance set at $p < 0.05$.

This study used a pre-test/post-test control-group design. The use of a missing context charge, such as software, was applied to everyone in the experimental group, along with standard CLL teaching and clear-up-the-confusion assignments, for statistical analysis. The control group, by comparison, used traditional means of remembrance much more commonly. Both groups received a pretest of the words to measure their prior knowledge and three posttests that gauge immediate and delayed learning. This experimental design allowed for a comparison of the effectiveness of CLL with traditional educational methods.

Fifty undergraduate engineering students (aged 19 to 21) were intentionally chosen from first- and second-semester ESP classes. The participants were randomly divided into experimental and control groups. The study only included engineering students on purpose to make sure the sample was homogeneous. This meant that students from other faculties or academic levels were not included.

Before each post-test, the experimental group took part in two one-hour training sessions (**Appendix B**). These sessions included lessons on context clues, including synonyms, antonyms, and semantic links. After that, there were both solo and group tasks, such as semantic mapping, collocation analysis, and examination of root words and affixes. For guided practice, real engineering publications, including manuals, research papers, and textbooks, were used. Extra worksheets were provided to assist with problems related to polysemy, semantic networks, and collocations. The main goal was to improve understanding and memory by putting words into important academic contexts.

On the other hand, the control group had the same number and length of sessions, but they only used word lists and dictionary definitions to learn vocabulary. Their learning did not include any consideration of semantic or contextual relevance. The courses focused on memorization techniques but lacked examples, exercises, and interactive teaching activities that would help students grasp the material.

The pretest and posttests (**Appendix A**) were used to assess the students' knowledge and recall of vocabulary. Posttest 1 assessed students' understanding of context clues; Posttest 2 evaluated their immediate learning; and Posttest 3 evaluated their delayed retention of knowledge two weeks later. Each evaluation consisted of 50 multiple-choice questions, each valued at 2 points, and was evaluated using a rubric that assessed correct contextual applicability.

To ensure that the test items were clear, doable, and aligned with the study's goals, a pilot study was conducted with ten ESP students who did not participate. Changes were made to make the instructions clearer and the test items easier to understand. Cronbach's alpha was 0.81 for the pretest and 0.85 for the posttests, indicating acceptable reliability of the instruments.

We used Independent Samples T-tests to compare the means of the groups and one-way repeated measures ANOVA to keep track of how vocabulary grew over time. These analyses were conducted using SPSS (Version 25.0), with significance set at $p < 0.05$, facilitating a thorough assessment of CLL about conventional vocabulary education methods.

4. Data Analysis and Results

Quantitative data were collected from participants through proficiency tests, post-tests, immediate tests, and delayed tests. SPSS (Version 25.0) was used to analyze the data. The primary purpose of the proficiency test was to determine whether both groups had the same level of proficiency. Post-test one was designed to assess the impact of training sessions on CLL and the students' ability to deci-

pher ambiguous meanings. The immediate test aimed to determine the immediate impact of CLL on vocabulary retention, while the delayed test assessed the long-term effect of CLL on vocabulary retention. The results and data are presented below. Before the data analysis, the reliability of the test was assured. **Table 1** shows the reliability of the tests.

Table 1. Reliability Statistics.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.787	0.705	4

Cronbach's Alpha, a measure of internal consistency, was used in the reliability analysis test and found to be acceptable. Cronbach's Alpha value for the overall test was 0.787, indicating that the test items were sufficiently reliable in measuring the desired construct. Additionally, Cronbach's Alpha is based on standardized items (0.705), which further strengthens the consistency of the test items. The total number of four items in the analysis was four, which indicates that these reliability coefficients allow us to conclude with some reliability that the test is stable and reliable, a logical requirement in a measure of proficiency.

4.1. Proficiency Test

When participants were selected from the first and second-semester engineering students, a pretest or proficiency test was conducted at the beginning to measure the vocabulary proficiency level of both groups (**Table 2**).

Table 2. Group Statistics of Proficiency Test.

Group Statistics					
Group		**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Proficiency Test	**Experimental Group**	25	70.2400	2.53772	0.50754
	Control Group	25	70.4800	2.66333	0.53267

As shown in the results of the proficiency test, both the experimental and control groups had equivalent vocabulary proficiency. The experimental group (M = 70.24, SD = 2.54) had a mean score that was almost identical to that of the control group (M = 70.48, SD = 2.66). Moreover, the standard error of the mean is relatively low for both, which backs the claim that observed means are the actual population parameters. The finding that there was no significant difference in vocabulary knowledge between the two groups suggests that the intervention on the experimental group would create a significant difference. **Table 3** shows the results of the pretest or proficiency test of both groups.

The independent samples t-test above revealed no significant difference in vocabulary proficiency between the experimental and control groups. Levene's test for equality of variances yields a significance of. 0.832, which confirms that the assumption of equal variances is satisfied. The t-test results ($t(48) = -0.326$, $p = 0.746$) indicated that the difference in means (-0.24) was not statistically significant. The 95% confidence interval for the mean difference is -1.719 to 1.239, suggesting that any difference is not actual but rather due to variation. These findings confirm that both groups had equivalent levels of vocabulary proficiency.

The variations observed in previous studies regarding test outcomes for ESP learners, particularly in word retention and unclear meanings, stem from multiple factors identified in existing research. To start with, vocabulary instruction in language learning settings often lacks standardized methods; that is to say, educators frequently remain unsure about optimal teaching strategies, resulting in inconsistent mastery levels among learners [70]. The directionality of learning approaches—that is, whether students study the target language from their native tongue or

vice versa—is another crucial factor. This has a significant impact on how well students acquire vocabulary, and it varies depending on their skill level. Learners with lower proficiency levels typically gain more from studying a target language than their mother tongue. However, higher-skilled people typically perform better when using native-to-target techniques, indicating that disparities in proficiency lead to unequal test performance [71]. Furthermore, assessment tools like Yes/No tests, commonly used to evaluate vocabulary knowledge, demonstrate limited success in enhancing word skills. This limitation arises partly from their low contextual engagement and small-scale research designs, which may not fully capture the broader capacities of learners [72]. Challenges in mastering word combinations, as observed among Indonesian English learners, add another layer of complexity to the learning process. These difficulties often originate from native language interference and irregular application of appropriate word pairings [73]. Lastly, the stability of contextual meanings during learning proves critical—unpredictable or shifting contexts tend to weaken recall and retention, underscoring the need for consistent learning environments to support actual vocabulary uptake [21]. Taken together, these elements highlight the intricate nature of vocabulary learning and emphasize the necessity for customized, context-aware instructional strategies to enhance test results for ESP students.

Research Question 1: What is the impact of CLL on short-term and long-term vocabulary retention for ESP learners?

Table 3. Independent Samples Test of Proficiency Test.

Independent Samples Test										
		Levene's Test for Equality of Variances								
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Proficiency Test	Equal Variances Assumed	0.046	0.832	-0.326	48	0.746	-0.24000	0.73575	-1.71933	1.23933
	Equal Variances Not Assumed			-0.326	47.888	0.746	-0.24000	0.73575	-1.71942	1.23942

4.2. Post-test 1

After the proficiency test, the control group was given a list of ambiguous words in the engineering discipline, while the experimental group received two training sessions involving CLL clues. After the session was over, a post-test was conducted to measure the impact of the training sessions on the experimental group, and its performance was compared with that of the control group. **Table 4** represents the group statistics of post-test 1.

An independent-samples analysis revealed notable differences in vocabulary performance between the experimental and control groups on the posttest. The experimental group (N = 25) achieved a significantly higher mean score (M = 79.20), SD = 2.31) compared to the control group (N = 25; M = 70.00, SD = 3.16), indicating superior vocabulary acquisition among participants who received the experimental intervention. In contrast to the control group, which showed more notable variability, the experimental group's smaller standard deviation indicates more consistent performance. The significant mean difference between the two groups in these results highlights the effectiveness of the intervention in improving vocabulary learning.

Table 5 illustrates the impact of the training sessions on the experimental group and the traditional methods of vocabulary learning used by the control group.

Table 4. Group Statistics of Post-test 1.

Group Statistics					
Group		N	Mean	Std. Deviation	Std. Error Mean
Post-test 1	Experimental group	25	79.2000	2.30940	0.46188
	Control group	25	70.0000	3.16228	0.63246

Table 5. Independent-samples Test of Post-test 1.

Independent Samples Test										
		Levene's Test for Equality of Variances								
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Post-test 1	Equal variances assumed	1.288	.262	11.747	48	0.000	9.20000	0.78316	7.62536	10.77464
	Equal variances not assumed			11.747	43.931	0.000	9.20000	0.78316	7.62158	10.77842

An independent-samples t-test was conducted to compare the vocabulary performance of the experimental and control groups on the posttest. Levene's test for equality of variances indicated no significant difference in variance between the groups ($F = 1.288$, $p = 0.262$), supporting the assumption of homogeneity. The results revealed a statistically significant difference in post-test scores, $t(48) = 11.747$, $p < 0.001$, with the experimental group ($M = 79.20$, $SD = 2.31$) outperforming the control group ($M = 70.00$, $SD = 3.16$) by a mean difference of 9.20 points (95% CI [7.63, 10.77]). This substantial and noteworthy effect demonstrates that, in comparison to the control condition or conventional vocabulary learning techniques, the experimental intervention—contextual lexis learning training—significantly improved vocabulary acquisition.

The differences observed in evaluation results for ESP learners during post-test 1 arise from various factors identified through existing research. A key aspect relates to the differences in how vocabulary learning methods are implemented and their effectiveness, as different approaches may yield varying outcomes depending on learners' skill levels and the learning environment. For instance, studies conducted by Masato Terai and colleagues have demonstrated that the direction of knowledge transfer—whether moving from a second language to a native language or the reverse—affects memorization efficiency based on learners' capabilities. That is to say, less proficient learners showed more significant improvement when using L2-to-L1 sequences, whereas more advanced learners achieved better retention through L1-to-L2 ordering patterns. However, the interaction between language directionality and individual proficiency levels yields measurable differences in learning outcomes, suggesting that instructional strategies should consider these variables to optimize knowledge acquisition processes [71].

Concurrently, analysis by Fayzullayevna highlights the consequences of mental engagement and drive in lexical mastery, proposing that techniques such as contextual assimilation or mnemonic devices can recover word handling capabilities, although earlier research presents conflicting conclusions regarding their direct relationship with long-term retention [74]. Furthermore, examinations of vocabulary tactics within ESP environments advise that employing varied learning strategies can markedly influence learner achievement. That being said, the practical value of these methods might fluctuate across scenarios, resulting in

irregular assessment performance [75]. These results show how complicated the relationships are that lead to vocabulary internalization. They also show how important it is to make tailored learning programs that take into account each student's unique traits and the context in which they are learning. This could lead to more consistent improvements in language retention if redesigned instructional approaches take these complicated elements into account.

4.3. Post-test 2 or Immediate Test

Unlike previous tests, which were conducted one week after the training sessions, the immediate test was conducted immediately after the training sessions to measure the immediate impact of CLL (**Table 6**).

Vocabulary retention was immediately tested in both the experimental and control groups; an independent-samples t-test and an analysis of variance were used to compare the results. The experimental group (N = 25, M = 81.92, SD = 2.68) showed a significantly greater retention than the control group (N = 25, M = 72.08, SD = 2.80). The lower standard deviation for the treatment condition suggests that the participants performed more uniformly compared to those in the control condition. For the experimental group, the standard error of the mean (SEM = 0.54) was marginally lower compared to the control group (SEM = 0.56), providing further evidence of the stability of the experimental group's mean score. So, results indicate positive immediate retention of vocabulary in the group exposed to the intervention.

Table 7 illustrates the immediate impact and retention of learned vocabulary by both groups in comparison.

Table 6. Group Statistics of Immediate Test.

Group Statistics					
Group		N	Mean	Std. Deviation	Std. Error Mean
Immediatetest	Experimental group	25	81.9200	2.67582	0.53516
	Control group	25	72.0800	2.79762	0.55952

Table 7. Independent Samples Test of Immediate Test.

Independent Samples Test										
		Levene's Test for Equality of Variances								
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Immediatetest	Equal variances assumed	0.000	0.989	12.709	48	0.000	9.84000	0.77425	8.28326	11.39674
	Equal variances not assumed			12.709	47.905	0.000	9.84000	0.77425	8.28318	11.39682

The independent samples t-test revealed that the experimental group (M = 81.92, SD = 2.68) successfully retained a significantly higher vocabulary than the control group (M = 72.08, SD = 2.80), indicating superior perfor-

mance. Levene's test for equality of variances (F = 0.000, $p = 0.989$) justified the use of the t-test, assuming homogeneity of variances among groups. This analysis showed a 9.84-point difference between the two groups with t(48) = 12.709, $p < 0.001$, 95% CI [8.28, 11.40], with a confidence interval that does not include zero, providing evidence of a strong effect and suggesting that such an extreme result is unlikely to occur by chance if the null hypothesis is true. This very low p-value ($p < 0.001$), along with the considerable mean difference, indicates that the experimental intervention significantly enhanced immediate retention of vocabulary. The very large t-value (12.709) and the narrow confidence intervals also strengthen the argument that the experimental group's better performance is due to a real treatment effect, rather than random chance. The experimental procedure, instructional method, and/or curriculum may be attributed to the improved memory of domain-specific vocabulary words compared to the control condition.

Previous studies have revealed a delicate balance between context-based development and rote learning methods employed by ESP learners in the context of vocabulary ambiguity and retention. However, the complete correlation is that it can trigger success factors, which can also be referred to as over-replication through immediate distractors, allowing their word skills to be retained long enough for rehearsal in a meaningful way in isolation. Findings also support this, as context-based strategies outperform rote methods on immediate tests, with results not as definitive for delayed tests, indicating that context helps promote the initial learning of word meanings [76]. Similarly, while competition is important in all learning, it is doubly so in ESP, in which learners are required to develop a specialized terminological lexicon relevant to their respective field of application (FA). This requires a teaching strategy that encourages vocabulary to be utilized in professional scenarios, which will ultimately improve both receptive and productive language skills [66]. Additionally, semantic disambiguation is required, as each word has one or more meanings depending on the context. High-quality lexical-semantic knowledge, informed by the individual's linguistic history, underpins this process and is critical for rapid word-meaning access [77]. Additionally, the use of retrieval practice techniques, including low-stakes quizzes and flashcards, can provide further assistance in solidifying vocabulary retention by encouraging active recall and metacognition. However, potential challenges, such as test anxiety and rote memorization, should be mitigated [45]. This synthesis of findings offers valuable insights into the role of context in vocabulary learning for ESP learners, highlighting the potential of instructional practices to capitalize on contextual cues and support vocabulary acquisition.

4.4. Post-test 3 or Delayed Test

This delayed test was conducted two weeks after the completion of two training sessions on CLL or context clues. The purpose of the test was to measure the impact of CLL on students' long-term retention. The results and data are analyzed below (**Table 8**).

Table 8. Group Statistics of Delayed Test.

Group Statistics					
Group		N	Mean	Std. Deviation	Std. Error Mean
Delayed test	Experimental group	25	87.5200	2.40000	0.48000
	Control group	25	75.2000	2.08167	0.41633

This substantial output confirms the significant effect of contextual lexis learning on the experimental group. As can be seen, the mean score for the experimental group (M = 87.52) is higher than that of the control group (M = 75.20), which indicates that participants who used contextual lexis learning contexts performed better on the delayed test. More importantly, the standard deviation values (experimental group: SD = 2.40 vs. control group: SD = 2.08) suggest the degree of fluctuation in achievement after intervention, with similar influence effects. The SEM values

0.48000 and 0.41633, which further corroborate the reliability of these differences. In summary, these results suggest that learning lexis in a contextual context aids the retention and use of lexical knowledge over time, as evidenced by the experimental group's improved performance.

Table 9 presents a comparative analysis of the delayed retention of learned vocabulary in the experimental and control groups.

Table 9. Independent-samples Test of Delayed Test.

Independent Samples Test										
		Levene's Test for Equality of Variances	t-test for Equality of Means							
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Delayed test	Equal variances assumed	0.322	0.573	19.389	48	0.000	12.32000	0.63540	11.04244	13.59756
	Equal variances not assumed			19.389	47.060	0.000	12.32000	0.63540	11.04178	13.59822

The independent-samples t-test result serves as compelling evidence that contextual lexis learning (CLL) works significantly better for long-term vocabulary retention in the experimental group than in the control group. The mean difference shows that the experimental group outperformed the control group with a difference of 12.32. Such a significant difference, to the point of statistical significance, albeit with a small standard error (0.63540), suggests that CLL makes significant contributions to delayed vocabulary retention.

Significance value of Levene's test for equality of variances was 0.573, which is greater than. 05, indicating that the assumption of homogeneity of variances is not violated. Therefore, we must focus on the t-test results for the condition labeled "Equal variances assumed". A very high t-value ($t(48) = 19.389$) and p-value ($p < 0.001$) are well below the traditional threshold of 0.05. In other words, this indicates that the difference was statistically significant, and we reject the null hypothesis that there was no significant difference between the experimental and control groups in terms of long-term vocabulary retention.

In addition, the 95% confidence interval [11.04244,13.59756] does not include zero, supporting the conclusion that the experimental group retained significantly more vocabulary over time than the control group. This demonstrates that CLL is an effective method for improving long-term vocabulary recall, as the subjects in the CLL group showed the best results on the delayed test.

Previous studies examining the effectiveness of lexis in context and vocabulary retention for ESP learners have revealed several contradictions and findings, particularly in the area of delayed testing. For example, research has shown that teaching contextual vocabulary — that is, teaching vocabulary through meaningful contexts rather than memorizing isolated words — improves immediate vocabulary retention compared to rote memorization methods. Another research gives some indication of how those kinds of findings play out in real-world learning, with context-based strategies found to be more effective than rote rehearsal in immediate testing. However, these differences were not statistically significant for delayed tests, indicating that retention may decline over time without continued contextual reinforcement [78]. This finding is consistent with results [79], which show that the context method significantly outperformed definitions and synonyms on both immediate and delayed tests, highlighting the more significant role of context in long-term retention. Hunchenko explains that the inconsistency in delayed test results may be a reaction to the lack of continuous exposure and practice [66], stressing that to learn vocabulary, learners need continuous

exposure, practice, time, and repetition, which he points out is often not carried out or sustained over time, as in my case with vocabulary acquisition. This reflects the need for context, continuity, repetition, and exposure through a broader range of methods, such as extensive reading and listening, to ensure that vocabulary is retained, reinforced, and applied over time. Additionally, Aswadi muses that choosing socially and culturally relevant vocabulary can enhance understanding and retention [61]. However, while these findings are insightful, van Uum states that [80] difficulties in effective implementation of this approach against the framework of context and retention must be evaluated; students use a memorization framework that they are most familiar with and this can often result in a return to adequate memorization methods, as context, especially in languages such as Latin, which are replete with extensive grammatical frameworks, can become challenging.

Research Question 2: How do contextual lexis learning approaches address ambiguity?

4.5. Descriptive Statistical Overview

The descriptive analysis reveals a strong learner preference for contextual vocabulary learning, with high agreement on its role in enhancing retention, disambiguating word meanings, and boosting confidence in ESP contexts. Learners favor example-based teaching and actively engage with word context, highlighting the need for domain-specific, context-rich instruction.

Table 10 presents the descriptive statistics of the survey, showing how contextual lexis learning aids in the disambiguation of meaning and the retention of learned vocabulary.

Table 10. Descriptive Statistics of Questionnaire.

Descriptive Statistics			
	N	**Mean**	**Std. Deviation**
1. How old are you?	25	20.4400	0.71181
2. What is your gender?	25	1.8800	0.33166
3. What is your level of study?	25	1.0000	0.00000
4. Which department do you belong to?	25	1.0000	0.00000
5. I find it easier to remember new vocabulary when I learn it in context rather than in isolation.	25	3.9200	0.81240
6. Contextual clues help me understand the different meanings of ambiguous words.	24	4.1250	0.33783
7. Learning vocabulary through real-life situations or texts improves my retention.	25	3.8800	0.78102
8.I often forget vocabulary that I memorized without context.	25	4.1200	0.43970
9. Context-based vocabulary exercises are more helpful than simple word lists.	25	4.1200	0.60000
10. I feel more confident using the vocabulary I learned through contextual learning in my field of study.	25	4.2400	0.43589
11. Ambiguity in word meaning is less confusing when words are learned through context.	25	3.8000	0.50000
12. I prefer teachers to explain vocabulary through examples and situational usage.	25	4.2000	0.40825
13. Vocabulary retention improves when I can relate new words to my specific academic or professional context.	25	3.8400	0.68799
14. I actively try to understand the context of new words when reading or listening in English.	25	4.1600	0.47258

To illuminate the landscape of learner perceptions surrounding contextual lexis learning (CLL), this study draws upon descriptive statistics from a cohort of 25 ESP learners. The demographic baseline reveals a mean age of 20.44 years (SD = 0.71), reflecting a relatively homogenous young adult group. The participants, all from the same level of study and department (Mean = 1.00, SD = 0.00 for both), formed a tightly knit academic cohort. The gender distribution leaned slightly towards a male-dominant group (Mean = 1.88, SD = 0.33), based on the coding system applied.

Delving into the core perceptions surrounding vocabulary acquisition, the findings reveal a strong overall endorsement of contextual learning strategies. Notably, learners expressed considerable confidence in their ability to comprehend word meanings through contextual cues. Statement 6—"Contextual clues help me understand the different meanings of ambiguous words"—garnered a high mean score of 4.13 (SD = 0.34), indicating a consistent belief in the disambiguating power of context. Likewise, the preference for vocabulary explanation through real-life or situational examples was nearly unanimous (Mean = 4.20, SD = 0.41), suggesting a pedagogical alignment with constructivist approaches.

Crucially, the perception that vocabulary learned in context is easier to remember was also strong (Mean = 3.92, SD = 0.81), though marginally lower than other items, hinting at individual variability in memory processes. On the other hand, the reverse scenario—memorizing vocabulary without context—was met with strikingly high agreement (Mean = 4.12, SD = 0.44), underscoring the transient nature of rote learning. The convergence of these two variables paints a compelling picture: learners not only favor but seem to require context to retain and operationalize new lexical items.

Furthermore, Statement 10,"I feel more confident using vocabulary I learned through contextual learning in my field of study," garnered the highest mean (4.24, SD = 0.44). This underscores the empowering role of relevance and disciplinary alignment in vocabulary retention. Statement 13 complements this insight, showing that learners strongly believe their retention improves when vocabulary is anchored in their specific academic or professional context (Mean = 3.84, SD = 0.69). These insights add empirical weight to the call for more domain-specific vocabulary instruction in ESP settings.

Additionally, the data reveal a proactive learner mindset: participants actively attempt to grasp the contextual meanings of new words when reading or listening in English (Mean = 4.16, SD = 0.47). Such a learner agency is a promising sign, indicating the internalization of metacognitive strategies cultivated through CLL interventions.

Interestingly, while the perception that ambiguity is reduced through context (Mean = 3.80, SD = 0.50) received slightly lower ratings compared to other items, it still reflects a positive leaning. This minor dip may reflect the inherent complexity of polysemous or technical terms in ESP contexts, which often demand more than just contextual familiarity for full mastery.

Altogether, these descriptive statistics provide a compelling narrative: learners not only value but also deeply rely on contextual learning to navigate lexical ambiguity and foster retention. The pattern of high mean values across all contextual lexis statements suggests a pedagogical paradigm in which meaning is not memorized but lived, constructed, and applied. These findings justify a shift away from decontextualized lists and toward immersive, situated vocabulary instruction that speaks to the learner's academic and professional future.

4.6. Findings and Thematic Analysis of Interviews

A thematic synthesis of interview data collected from five ESP teachers and five Civil Engineering students is presented below. Thematic analysis was conducted inductively, with patterns emerging from participants' descriptions of their vocabulary learning and teaching practices. Data revealed both convergence and divergence in perspectives, giving rise to the following core themes: (1) Context as a Catalyst for Lexical Retention; (2) Navigating Polysemy through Disciplinary Cues; (3) Challenges of Decontextualized Vocabulary Learning; and (4) The Role of Authentic Practice and Materials in ESP Vocabulary Acquisition.

4.6.1. Context as a Catalyst for Lexical Retention

Both teachers and students overwhelmingly emphasized the power of contextual learning in facilitating long-term retention of technical vocabulary. Context served not merely as an accessory to meaning but as a cognitive bridge between abstract lexical forms and their functional embodiment within engineering discourse. For instance, Mr. Rakib Hossain reflected,

> *"Just learning it from a list did not help, but when I saw it in a construction site plan, referring to the structure supporting the ends of a bridge, it clicked instantly."*

Similarly, student Foysal echoed this experiential alignment:

> *"I just memorized ['curing'] from a vocabulary list before, but I forgot. Then in our construction technology class, the teacher showed the curing process… From that example, I finally understood."*

These responses demonstrate how learning becomes more memorable when vocabulary is not presented as isolated terminology but instead embedded in real, tangible civil engineering scenarios. The context brings abstract words to life, making them lived knowledge.

4.6.2. Navigating Polysemy through Disciplinary Cues

Lexical ambiguity emerged as a frequent obstacle, especially in words with common and technical meanings. However, both cohorts described strategies of disambiguation rooted in disciplinary context—sentence structure, surrounding lexis, genre awareness, and technical visuals. M.S. Nafisa noted,

> *"Words like 'section,' 'beam,' or 'column' are used differently in literature, but in civil engineering they have precise meanings."*

Similarly, Arman, a final-year student, remarked:

> *"I learned the word 'elevation.' I thought it only means height, but in that drawing it meant a side view of the building."*

Students like Nusrat emphasized contextual matching:

> *"I see the other words in the sentence and guess which meaning fits… like 'joint' in structural class means something else than in general life."*

These excerpts illustrate how contextual reading within the discipline empowers learners to discern multiple meanings with confidence, transforming ambiguity into a learning opportunity rather than a barrier.

4.6.3. Challenges of Decontextualized Vocabulary Learning

The participants repeatedly critiqued rote memorization and dictionary-based approaches as insufficient and unsustainable. A lack of authentic exposure to vocabulary use in practice was perceived as a key barrier. Mrs. Tanzina Rahman candidly noted,

> *"Students memorize terms but don't see how they function in site reports or project management software, so they forget them easily."*

Student Mehedi similarly lamented,

> *"Many students try to memorize without understanding. So it gets forgotten easily."*

Tamanna added nuance by highlighting limited production opportunities:

> *"We don't get enough speaking or writing practice in class using these words. Also, books are too formal."*

These accounts draw attention to a disconnect between vocabulary instruction and application. When technical terms are taught without meaningful context, they fail to transition from short-term memory to practical usage.

4.6.4. The Role of Authentic Practice and Materials in ESP Vocabulary Acquisition

Participants across the board emphasized the transformative role of applied, context-bound learning tasks in retaining and operationalizing ESP vocabulary. These included blueprints, project reports, annotated drawings, site

visits, and simulated tasks. Mr. Habib noted:

> *"Drawing labeling tasks, glossary building from design manuals, and collaborative drafting projects. These are hands-on and vocabulary-rich."*

Likewise, Nusrat found project work most effective:

> *"Working in groups to prepare project presentations helps. Also, when teachers explain with real photos or drawings, it gives a clear picture."*

Tamanna highlighted the use of video-based demonstrations and reflection logs:

> *"Video-based explanations, site visit reflections… help me retain new words."*

Such practices not only support retention but also promote the transfer of vocabulary into authentic discourse situations. It is within these applied settings that technical language truly becomes communicative and purposeful.

4.6.5. Synthesis and Implication

The interviews show that context is more than just helpful; it is necessary for learning vocabulary in ESP in the discipline of Civil Engineering. Both professors and students stressed how important context is for understanding, remembering, and using technical jargon. The field-specific environment not only gives vocabulary a purpose, but it also boosts the learner's confidence, which is a psychological factor that lexical studies often ignore. This study shows how important it is to include real-world tasks, contextualized information, and repeated exposure in the design of an ESP curriculum. This method criticizes traditional ways of glossing and memorizing, instead suggesting a paradigm where context serves as the curriculum and language is learned by real-life use rather than just remembering it. When terminology is unclear, polysemy is not a problem but a chance to teach. It can help students understand concepts better through disciplinary literacy.

5. Findings and Discussion

The study's quantitative results show that Contextual Lexis Learning (CLL) has a big, positive influence on ESP learners' vocabulary retention in both the short and long term. Post-test 1 showed a statistically significant difference between the experimental group (M = 79.20) and the control group (M = 70.00), with a mean difference of 9.20 ($p < 0.001$). This shows that CLL training greatly improved vocabulary understanding right away. The immediate test further supported these findings, as the experimental group (M = 81.92) outperformed the control group (M = 72.08). This shows that being exposed to the context helps with initial retention. The delayed test, administered two weeks after the intervention, revealed a larger difference (M = 87.52 vs. M = 75.20), supporting the notion that CLL enhances long-term word recall. These results support earlier research [81,82] that suggests contextual learning helps people remember vocabulary better by linking it to real-life situations instead of just memorizing it.

Qualitative data from learner surveys and interviews clarified the mechanisms underlying CLL's efficacy. Participants mostly concurred that contextual vocabulary acquisition (M = 3.92–4.24 on a 5-point scale) facilitated retention and disambiguation, especially for polysemous technical terminology. One student observed that the term "elevation" in an engineering drawing elucidated its specific meaning within the discipline, while another highlighted that practical examples, such as construction site plans, reinforced memory retention. Educators confirmed these findings, emphasizing that conventional list-based techniques led to rapid forgetting, whereas contextualized activities (e.g., project reports, annotated diagrams) enhanced long-term recall. These findings endorse the constructivist perspective that vocabulary is optimally learnt through active interaction with real materials [54], wherein meaning is negotiated within disciplinary discourse rather than conveyed in isolation.

Thematic analysis of the interviews identified four primary insights. (1) Context functions as a cognitive anchor, converting abstract concepts into applicable knowledge; (2) Disciplinary cues, such as syntactic structure and technical visuals, assist learners in addressing lexical ambiguity; (3) Decontextualized learning methods, including rote memorization, result in short-term retention; and (4) Authentic tasks, such as blueprint analysis and site simulations, link recognition with practical application.

Themes highlight the importance of integrating CLL into ESP programs, as it enhances retention and fosters learner autonomy and confidence. The study's findings challenge traditional vocabulary teaching methods, advocating for a context-as-curriculum approach that integrates lexical acquisition within authentic disciplinary practices. Future research may investigate the scalability of CLL across various ESP topics and its integration with digital tools, including AI-driven corpora, to enhance personalized learning.

The conclusions from the theme analysis correspond with various insights from the supplied studies, especially concerning the incorporation of cognitive methods and genuine situations in language acquisition. The focus on context as a cognitive anchor and the application of disciplinary cues to resolve lexical ambiguity align with the findings that underscore the notable enhancements in vocabulary proficiency achieved through cognitive strategies in CLIL curricula [83] the significance of authentic tasks in connecting recognition with practical application is corroborated by the advantages of CLIL, which amalgamates language acquisition with subject matter to improve linguistic competency and comprehension of information. The criticism of decontextualized learning approaches corresponds with the literature on CLIL, which underscores the necessity for immersive and meaningful learning experiences to enhance comprehension and recall [81,83]. The findings from the theme analysis contest vocabulary teaching methods, promoting a context-as-curriculum approach that diverges from traditional approaches that may inadequately incorporate genuine disciplinary procedures [82]. The integration of digital technologies, such as AI-driven corpora, to improve personalized learning represents a promising avenue for future study, highlighting the necessity for continuous professional development and resource allocation in CLIL programs [83]. The findings from the theme analysis endorse the amalgamation of cognitive and contextual techniques in language acquisition, while also emphasizing the need for more investigation into the scalability and digital incorporation of these methodologies.

6. Conclusions

The study found that CLL makes it much easier for ESP learners, especially those in engineering professions, to recall language in the short and long term. The experimental group, which used CLL methods, fared better on both the immediate and delayed post-tests than the control group. The changes were statistically important ($p < 0.001$). These conclusions are further reinforced by qualitative data. Both students and teachers underlined how crucial it is to be exposed to varied contexts to help clarify specialist language and boost recall. Thematic analysis showed that context serves as a cognitive anchor, disciplinary cues assist in making things clearer, and real-world tasks are necessary to bridge the gap between recognition and application. These results back up constructivist theories of learning, which claim that the best method to learn new words is not just to memorize them, but to use them in real-life, discipline-specific situations.

There are a lot of wonderful things in this study, but there are also a lot of bad things. First, the sample size was only 50 engineering students, which would make it tougher to use the results in other ESP disciplines or with bigger groups of people learning a language. Second, the study largely focused on receptive vocabulary knowledge (recognition and comprehension) instead of productive use (speaking and writing), which needs more research. Additionally, the intervention was relatively short; a longitudinal study could tell us more about how well people remember things over time. Lastly, although the study demonstrates the efficacy of CLL, it does not examine the combined effects of CLL and digital tools (e.g., AI-driven corpora or adaptive learning platforms), which could help students learn new words even better in ESP settings.

The results have a substantial impact on both theory and practice when it comes to creating and teaching an ESP curriculum. In theory, they add to cognitive and constructivist theories on vocabulary retention by showing how vital it is to learn words in context. The study advises that teachers should employ vocabulary lessons that are immersive and related to the subject instead of making students memorize word lists without any context. ESP programs should include real-world resources like technical reports, simulations, and project-based work to help students remember things and understand them better. Also, teacher

training should include CLL strategies like giving students real-world examples, semantic mapping, and retrieval practice to help them become more self-sufficient and sure of themselves. Future research should focus on scalable CLL models that leverage technology to make vocabulary lessons more tailored to the needs of diverse types of learners. Teachers can better prepare pupils for success in school and in their careers by offering them the right language through CLL in their ESP classes. This study adds to the growing body of research on how to teach vocabulary in a way that works. It gives those who teach English as a second language important ideas and makes room for more innovative ideas about how to learn a language in real life.

Author Contributions

All authors contributed equally to the conception, design, data collection, analysis, and writing of this study. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement

Confirming that written consent was obtained from all participants prior to submission of the article.

Data Availability Statement

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There is no conflict of interest among the authors.

Appendix A

Sample Tests

Read the Questions below and Choose the Correct Answer

1. "The **material's elastic properties** allow it to stretch and return to its original shape." What does the term **elastic** refer to in engineering?

   a) A type of band; b) A physical quantity; c) A mathematical model; d) A force exerted on a structure.

2. "The bridge design must account for the impact of wind **forces**." In engineering, what does the term **force** represent?

   a) A type of band; b) A physical quantity; c) A mathematical model; d) A force exerted on a structure.

3. "The electrical system is properly grounded to prevent electrical hazards." What does the term **ground** refer to in engineering?

   a) The surface of the Earth; b) A type of band; c) A mathematical model; d) A force exerted on a structure.

4. "The **head** of the bolt is secured tightly to prevent loosening." In fluid dynamics, what does the term **head** signify?

   a) The head of a bolt; b) A type of band; c) A mathematical model; d) Pressure head.

5. "The schematic diagram shows the flow **line** of the process." What does the term **line** represent in engineering diagrams?

a) A type of band; b) A line in a diagram; c) A mathematical model; d) A force exerted on a structure.

Appendix B

Intervention for Experimental Group

1. **Similarity:** The reader can guess the meaning of new words using signal words of similarity. These refer to the words or phrases mentioned formerly. See keywords or signal words of similarity below:
   Keywords:
   like / similarly / in the same way;
   as / the same as / just as.
   For example, Indonesia produces Ford cars and trucks. Soon, Thailand and Vietnam will be producing the same products with, no doubt, the same quality.
2. **Synonyms**: Look for synonyms or similar words nearby. These can provide clues about the word's meaning. Example: "When you **interpret** an image, you actively question and examine what the image connotes and suggests."
3. **Antonyms or Contrast**: Sometimes, the context contrasts the unknown word with another word. This contrast can help you infer the meaning. Example: "I **abhor** clothes shopping, but I **adore** grocery shopping."
4. **Root Words and Affixes**: Break down the word into its root and any prefixes or suffixes. This can reveal its meaning. Example: "The biologist studied the **herbivorous** animals in the forest." Here, herb + vore = herbivorous means animals that eat plants.
5. **Inferences**: Combine different context clues to make an educated guess about the word's meaning. Example: "The detective was **astute**, always noticing small details others missed."

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