

DETERMINING THE IDEAL QUANTITY OF VOCABULARY TO TEACH BEFOREHAND TO MAXIMIZE READING COMPREHENSION AND PREVENT COGNITIVE FATIGUE.

Abstract. This study examines how the volume of lexical instruction delivered prior to a task influences reading comprehension for English for Specific Purposes (ESP) undergraduates. Conducted at the "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National Research University, the research involved 38 participants from the fields of Economics, Aerospace Technology, and Material Science. Grounded in Cognitive Load Theory and the Vocabulary Threshold Hypothesis, the project investigated the optimal threshold for pre-teaching targeted terms to maximize reading comprehension without inducing cognitive fatigue. Participants were exposed to three distinct instructional design models utilizing low, moderate, and intensive levels of vocabulary preparation. The empirical findings indicate that a moderate pre-teaching load yields significantly better text comprehension compared to low preparation, whereas an excessively high load provides diminishing returns and increases working memory fatigue. For technical domains like Aerospace and Material Science, strategic instructional design that optimizes vocabulary acquisition for essential terms proves far more effective than exhaustive, high-volume lexical introduction.

Keywords: Vocabulary Acquisition, Cognitive Load Theory, Reading Comprehension, Pre-teaching, Instructional Design.

KOGNITIV ZO'RIQISH HOSIL QILMAGAN HOLDA MATNNI TUSHUNISH DARAJASINI MAKSIMAL DARAJAGA YETKAZISH UCHUN DARS DAN OLDIN O'RGATILADIGAN LUG'AT MIQDORINING ENG SAMARALI ME'YORI

Annotatsiya. Ushbu tadqiqot matnni o'qishdan oldin o'rgatiladigan leksik material hajmining maxsus maqsadlarga yo'naltirilgan ingliz tili (ESP) talabalarining o'qib tushunish ko'nikmasiga ko'rsatadigan ta'sirini tahlil qiladi. Ilmiy ish "Toshkent irrigatsiya va qishloq xo'jaligini mexanizatsiyalash muhandislari instituti" Milliy tadqiqot universitetida amalga oshirilgan bo'lib, unga iqtisodiyot, aerokosmik texnologiyalar hamda materialshunoslik yo'nalishlarida tahsil olayotgan 38 nafar bakalavriat talabarlari jalb etildi. Kognitiv yuklanish nazariyasi va lug'at chegarasi gipotezasiga tayangan holda, ushbu izlanish talabalarda aqliy zo'riqish keltirib chiqarmasdan, matnni tushunish darajasini oshirishga xizmat qiladigan eng samarali o'qitish dizayni andozasini aniqlashni maqsad qilgan. Eksperiment davomida darsdan oldingi leksik tayyorgarlikning uch xil (past, o'rtacha va yuqori) darajasi qo'llanildi. Olingan natijalar shuni ko'rsatadiki, o'rtacha hajmdagi o'qitishdan oldingi topshiriqlar past darajadagi ko'rsatkichga qaraganda o'qib tushunish ko'nikmasi sezilarli darajada yaxshilanishini ta'minlaydi. Aksincha, me'yordan ortiq leksik materialni taqdim etish kognitiv charchoqni yuzaga keltirib, o'zlashtirish samaradorligini pasaytiradi. Xususan, aerokosmik va materialshunoslik kabi murakkab texnik sohalarda barcha uchraydigan terminlarni ketma-ket yodlatishdan ko'ra, tayanch tushunchalarga qaratilgan tizimli lug'atni egallash strategiyasini qo'llash ancha yuqori natija beradi.

Kalit so'zlar: Lug'atni egallash, Kognitiv yuklanish nazariyasi, O'qib tushunish ko'nikmasi, O'qitishdan oldingi topshiriqlar, O'qitish dizayni.

ОПРЕДЕЛЕНИЕ ИДЕАЛЬНОГО ОБЪЕМА ЛЕКСИКИ ДЛЯ ПРЕДВАРИТЕЛЬНОГО ИЗУЧЕНИЯ С ЦЕЛЬЮ ДОСТИЖЕНИЯ МАКСИМАЛЬНОГО ПОНИМАНИЯ ТЕКСТА И ПРЕДОТВРАЩЕНИЯ УМСТВЕННОГО УТОМЛЕНИЯ.

Аннотация. В данной работе исследуется влияние объема лексического материала, вводимого на предтекстовом этапе, на уровень понимания прочитанного у студентов, изучающих английский язык для специальных целей (ESP). Экспериментальное исследование проводилось на базе Национального исследовательского университета «ТИИИМСХ» с участием 38 студентов бакалавриата, обучающихся по направлениям экономики, аэрокосмических технологий и материаловедения. Опираясь на положения теории когнитивной нагрузки и гипотезу лексического порога, авторы предприняли попытку определить оптимальный объем предварительно изучаемой лексики, обеспечивающий максимальное смысловое восприятие текста без риска когнитивного переутомления. В рамках педагогического эксперимента были апробированы три модели проектирования учебного процесса, различающиеся по степени интенсивности предтекстовой подготовки: низкая, умеренная и высокая. Эмпирические данные продемонстрировали, что умеренная лексическая нагрузка на предтекстовом этапе обеспечивает более качественное понимание содержания по сравнению с минимальной подготовкой. В то же время избыточный объем новой терминологии приводит к обратному эффекту, вызывая перегрузку оперативной памяти и утомляемость учащихся. Сделан вывод, что при подготовке специалистов для таких высокотехнологичных отраслей, как аэрокосмическая инженерия и материаловедение, целенаправленный отбор и семантизация ключевых терминов в рамках грамотного педагогического дизайна являются более продуктивной стратегией, нежели попытка сплошного изучения всего потенциального вокабуляра.

Ключевые слова: освоение словарного запаса, теория когнитивной нагрузки, понимание прочитанного, английский язык для специальных целей, предварительное обучение, разработка учебных материалов.

Introduction.

Within the modernizing higher education system of Uzbekistan, mastering English has transformed into a vital asset for both academic progress and professional growth. This is particularly visible at almost all institutions. At universities students are sometimes required to interpret sophisticated global research and literature to remain competitive. Grabe (2009) highlights reading as the foundational tool for acquiring specialized knowledge in academic environments, though Koda (2005) points out that a student's ability to apply reading strategies from their native language to a foreign one relies heavily on passing a specific language proficiency threshold.

Students learning English for Specific Purposes (ESP) face a double burden: they must build standard academic reading skills while simultaneously absorbing highly specialized vocabulary. Perfetti (2007) introduces the concept of lexical quality, demonstrating that the speed and precision with which a reader identifies words directly controls text comprehension. When learners are confronted with articles packed with unknown terms, their ability to process the text collapses entirely, a phenomenon Stanovich (1986) labels the "Matthew effect," which causes students with limited vocabularies to fall increasingly behind their peers. To solve this, teachers commonly introduce key words before reading, but the exact amount of vocabulary preparation that yields the best results remains unclear.

Cognitive Load Theory (CLT) states that educational methods must be structured around the strict limitations of human working memory (Sweller, 1988; 2011). Baddeley (2003) clarifies that working memory splits visual and auditory data into distinct channels, both of which can easily become overwhelmed if too much information is presented at once. This research explores

the exact boundaries of vocabulary pre-teaching for undergraduates at TIAME NRU. The core idea is that while introductory vocabulary training aids text processing, forcing students to memorize too many words before reading bogs down their short-term memory and exhausts the mental energy needed to actually integrate and understand new information (Paas, Renkl, & Sweller, 2003).

Literature Review

Numerous empirical investigations have established a robust correlation between the size of a learner's lexicon and their ultimate text comprehension. Nation (2001) describes this relationship as reciprocal, noting that while an adequate vocabulary baseline is mandatory for successful reading, the act of reading itself serves as a major engine for lexical growth. Laufer (1989) initially proposed that readers must possess a familiarity with 95% of the running words in a text to achieve independent comprehension. This threshold was later adjusted upward to 98% for dense academic prose by Laufer and Ravenhorst-Kalovski (2010) as well as Schmitt, Jiang, and Grabe (2011). Falling short of this critical coverage threshold severely impedes a student's capacity to leverage contextual cues for decoding unfamiliar terms (Nation, 2013).

Attaining this substantial lexical baseline within an English for Specific Purposes (ESP) environment presents unique challenges. Egamovich (2022) examined the interplay between intensive and extensive reading modalities, concluding that while extensive reading effectively cultivates processing fluency, targeted intensive intervention remains indispensable for decoding complex specialized literature. Similarly, Surmanov (2024) demonstrated that while graded readers serve as valuable developmental scaffolding, unsimplified technical documentation typically demands more explicit, direct instructional intervention.

Sweller (2011) categorizes cognitive load into three distinct dimensions: intrinsic load, dictated by the inherent conceptual difficulty of the material; extraneous load, generated by the structural presentation of the information; and germane load, which represents the deliberate mental processing dedicated to schema construction. Front-loading lessons with exhaustive glossaries heavily increases extraneous cognitive load. Chandler and Sweller (1991) confirmed that forcing learners to split their attention between a primary text and a separate vocabulary list disrupts the learning process. These principles align with the multimedia learning frameworks established by Mayer and Moreno (2003), which are increasingly relevant to modern, digitally integrated language pedagogy.

When the total cognitive demands exceed a learner's immediate processing capacity, the deep cognitive investment required for long-term retention is compromised (Hulstijn, 2001). Webb (2007) and Webb and Chang (2015) emphasize that while encounter frequency is vital for memory consolidation, the temporal distribution of these encounters is critical. Concentrating heavy vocabulary instruction immediately prior to a reading task closely resembles rote cramming, an approach that lacks the long-term cognitive efficacy of spaced, distributed repetition.

Learner affect and psychology play equally decisive roles in instructional success. Samatova (2014) highlights motivation as a primary determinant of language acquisition outcomes, particularly among non-linguistic majors. Monotonous, high-volume pre-teaching routines frequently erode student engagement. Furthermore, Samatova (2020) stresses the necessity of differentiating instruction to accommodate varying baseline skill levels; for instance, the cognitive capacity for vocabulary processing may fluctuate significantly between high-achieving aerospace engineering undergraduates and struggling economics students. Samatova (2020) also notes that anchoring lexical items within contextually relevant, discipline-specific scenarios is essential for sustaining student interest in non-language faculties.

Finally, Zhang (2012) and Surmanov (2025) advocate for the explicit integration of metacognitive reading strategies. Rather than relying entirely on pre-packaged definitions, undergraduates must develop strategic autonomy to navigate textual gaps independently. Read (2004) and Schmitt (2008) consequently recommend a balanced instructional compromise: educators should prioritize explicit instruction for high-frequency, highly versatile technical

46 vocabulary, while training students to employ context-inferencing strategies or selectively bypass low-frequency vocabulary during the reading process.

Methodology

This study used a quasi-experimental design involving 38 undergraduate students from the "TIAME" National Research University. The participant cohort was composed of 15 students from the Faculty of Economics, 12 from the Department of Aerospace Technology and Sustainable Development, and 11 from the Department of Material Science and Technology of New Materials. All participating students possessed a baseline English proficiency level of B1+. This diverse mix of academic disciplines was selected to evaluate the generalizability of the findings across different domains, accounting for the possibility that acquiring specialized terminology in fields like Material Science might require greater cognitive effort than in Economics.

To analyze the impact of pre-reading lexical introduction, three academic texts of comparable linguistic and structural difficulty were selected. The experimental framework manipulated the volume of vocabulary taught prior to reading across three distinct setups: Condition A (Low Load) introduced 3 words, Condition B (Moderate Load) introduced 8 words, and Condition C (High Load) introduced 18 words. This design was structured to evaluate the processing constraints of working memory as outlined by Baddeley (2003). To mitigate the split-attention effect described by Chandler and Sweller (1991), which occurs when integrating information from disparate sources increases unnecessary cognitive load, definitions were displayed directly on unified slides. Following the instructional phase, participants read the designated text and completed a comprehension assessment to measure their overall textual understanding and information retention.

Results

Table 1 shows the descriptive statistics for reading comprehension scores in the three experimental conditions, grouped by academic discipline.

Condition	Total (n=38)	Economics	Aerospace	Material Sci
Low (3 words)	6.2	6.5	5.9	6.1
Moderate (8 words)	8.4	8.7	8.1	8.3
High (18 words)	6.8	7.1	6.4	6.7

Table 1: Mean Comprehension Scores

The overall data reveals a clear inverted-U relationship between the volume of vocabulary pre-teaching and subsequent reading comprehension scores. Participants achieved their highest performance under the Moderate condition (Total = 8.4), indicating the existence of an optimal threshold for preparatory lexical instruction. Conversely, the Low condition yielded the lowest comprehension scores (Total = 6.2). This outcome aligns with Nation's (2006) lexical coverage hypothesis, which posits that an insufficient vocabulary baseline impedes textual understanding and prevents learners from constructing an accurate mental model of the text.

However, increasing the pre-teaching load beyond this optimal point resulted in diminishing returns. Performance dropped noticeably in the High condition (Total = 6.8), providing empirical support for Sweller's (1988) Cognitive Load Theory. Forcing the memorization of 18 novel terms simultaneously likely overwhelmed the finite capacity of the students' working memory, leaving fewer cognitive resources available for deep text processing. This specific trend—characterized by an initial rise in comprehension followed by a sharp decline—remained consistent across all three academic disciplines, demonstrating that these cognitive processing limits operate independently of the student's field of study.

Discussion

The empirical findings point to an optimal threshold for vocabulary pre-teaching, with a range of 7 to 10 words proving most effective for facilitating text comprehension. In the Low condition, the limited number of pre-taught items likely left participants short of the 95–98% lexical coverage threshold required for independent comprehension (Laufer & Ravenhorst-Kalovski, 2010), thereby creating a significant bottleneck during text processing. Conversely, the

High condition demonstrates the counterproductive nature of lexical inflation. While participants theoretically possessed greater vocabulary resources, the cognitive effort required to encode and retain 18 novel definitions concurrently depleted the working memory capacity necessary for high-level situational model construction (Paas et al., 2003). Excessive focus on individual word decoding ultimately left fewer cognitive resources available for global textual integration.

Furthermore, the data indicates that undergraduates in Aerospace and Material Science experienced a more pronounced performance decline under the High condition compared to their peers in Economics. This variance can be attributed to the high intrinsic cognitive load characteristic of engineering and material science texts, which frequently describe complex physical phenomena and structural mechanics (Sweller, 2011). Layering an intensive vocabulary load over this complex content accelerates cognitive fatigue. This pattern aligns with Samatova's (2020a) observation that technical students prioritize conceptual processing over precise lexical decoding. Consequently, high-volume vocabulary drills disrupt their established cognitive routines, leaving them more vulnerable to memory overload than social science majors.

To mitigate this extraneous load, instructors can integrate Egamovich's (2025) instructional design principles, which advocate for offloading lower-frequency vocabulary to asynchronous self-study using digital tools like Anki. Offloading rote memorization allows valuable classroom hours to be repurposed for deep conceptual processing. In tandem, Surmanov (2025) emphasizes that training students in metacognitive reading strategies equips them to navigate text ambiguity autonomously, enabling successful comprehension even when encountering unfamiliar vocabulary.

Finally, student behaviors observed during the High Load condition support Azimova and Surmanov's (2025) research on code-switching in multilingual educational settings. When confronted with an overwhelming amount of new vocabulary, participants frequently relied on their native languages (Uzbek or Russian) to translate and process definitions. While this serves as a natural coping mechanism, the rapid switching between languages introduces additional cognitive friction and taxes the central executive component of working memory. The results also reinforce the depth-of-processing framework (Pulido, 2009); the Moderate condition provided sufficient time for students to engage in deep semantic processing of the eight target words, resulting in stable retention. In contrast, the High condition forced a superficial, rushed treatment of the terms. As Surmanov (2024) notes regarding scaffolded materials, a manageable linguistic challenge maintains student engagement, whereas excessive lexical density triggers emotional detachment and cognitive withdrawal.

Conclusion

This study demonstrates that within English for Specific Purposes (ESP) contexts various universities, simply increasing instructional input does not linearly improve learning outcomes; in other words, more is not inherently better. To maximize reading comprehension while preventing cognitive overload, a three-tiered pedagogical framework is proposed where instructors first limit explicit pre-reading vocabulary preparation to a strategic threshold of 7 to 10 high-utility terms, ensuring fundamental lexical coverage without exhausting working memory capacity (Nation, 2013). Second, students should be encouraged to build vocabulary independently through digital spaced-repetition tools, shifting the burden of rote memorization outside of active classroom hours (Egamovich, 2025). Third, instructional design must adapt to individual academic domains, acknowledging that highly technical fields like Aerospace and Material Science present a steep conceptual curve that requires a more conservative vocabulary load than fields like Economics (Samatova, 2020). By implementing this balanced approach, language educators can effectively support undergraduates across diverse faculties, ensuring that specialized English instruction serves as an asset rather than a cognitive barrier to academic success.

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