AI-Based Vocabulary Instruction for Engineering Students: An ESP Perspective

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Abstract: Enhancing vocabulary is a vital component of English for Specific Purposes (ESP), for the students who write technical texts and academic discourses in professional contexts. Teaching vocabulary in traditional methods is unable to fulfil the functional language needs of the engineering students. As Artificial Intelligence (AI) is having an impact in every sector, education sector is no exception and vocabulary instruction in English language Teaching took significant swift from traditional to modern methods. This paper examines how AI tools can improve academic vocabulary acquisition, learner autonomy, and motivation. Challenges and implications for ESP practitioners will be discussed and proposes a framework for integrating AI-based vocabulary instruction into engineering education. The paper contributes to ongoing discussions on technology-enhanced ESP pedagogy and is relevant for educators, curriculum designers, and researchers.

Keywords: Vocabulary learning, ESP, engineering students, digital tools, technical vocabulary, AI-based instruction.

Introduction

Learning new vocabulary involves number of skills, including the ability to remember, comprehend, and use a word appropriately in speech or writing (Anis, 2023). Majority of the engineering students, particularly in ESL/EFL contexts, face persistent difficulties in acquiring and using technical and academic vocabulary accurately. Proficiency in English extends beyond general language competence to include mastery of discipline-specific vocabulary in present day engineering education. Engineering students are expected to understand technical manuals, project reports, research articles, and professional documentation. Also, students need to participate effectively in presentations and collaborative tasks.

Traditional approaches to vocabulary teaching—such as memorization of word lists or isolated definition-based instruction—often lack contextual relevance and fail to promote long-term retention or functional use. Apps such as Duolingo and Babbel and Chat GPT use AI to facilitate language learning, which is regularly practiced in a fun, game-like manner (Zhani& Wibowo,2023; Gerick, 2018). Language acquisition, particularly vocabulary development, is a cornerstone of effective communication and writing. English for Specific Purposes (ESP) emphasizes the alignment of language instruction with learners' academic and professional needs. Within this framework, vocabulary instruction plays a central role.

AI-based tools offer adaptive learning paths. Recent advances in Artificial Intelligence (AI) have introduced new possibilities for vocabulary instruction. AI gives real-time feedback, contextualized input, and learner-centered environments. This paper examines AI-based vocabulary instruction for engineering students from an ESP perspective, highlighting its theoretical grounding, pedagogical benefits, and practical challenges.

Effective ESP instruction requires vocabulary to be taught in authentic contexts that reflect really academic and professional tasks. AI-based tools are particularly well suited to address these needs, as they can draw on large datasets, authentic texts, and learner analytics to deliver customized vocabulary instruction.

Methods and Methodology:

The method involved the use of AI in vocabulary Learning tools a qualitative approach- narrative analysis, semi - structured interviews and observation.

A pilot study is conducted for a class of 72 third year engineering students of one of the colleges of Andhra Pradesh selected for the study. Students were observed for a period of six weeks on how AI tools had an impact on learner's language, vocabulary in particular. To evaluate each activity, two weeks have been alloted. Three activities are assigned in a period of six weeks.

During the first week, students were given the task of writing self-introduction in the classroom. Teacher evaluates the writing task mostly focusing on the vocabulary students had used based on their standard. Later, a home task is set to re-write their own introduction using AI tools such as Chat GPT, and Grammarly. Learners identified the nuances as well as the word alternatives suggested by AI to make their sentences. When the learners of L2 turn in the following week, presentation are made and teacher evaluated their narratives, emphasis on the vocabulary used. Three hours had been allotted to do this activity in each week.

In the third week, a five-minute presentation session is conducted. Technical topics related to the core branches are selected. Learners write what they had presented in their observation notebook. Teacher assessed the presentations evaluated the learner's language. Later, learners used AI tools to refine their language and observations made. The following week, students presented the refined version to the class. Likewise, in the subsequent weeks, tasks on technical report writing was assigned. The same process of evaluation had been repeated.

The study's design ensured that the module included activities focused on expanding vocabulary, improving word choice, and developing writing fluency. The program was designed with measurable outcomes in mind, targeting specific challenges in vocabulary acquisition.

Results:

After the six-week study, observations were recorded after every week activity is over. Narrative analysis is noted by the teacher. Data collected from the learners through semi-structured interviews. Among the 72 students, 55 students that is 76% put effort in using various technical apps for the refined version. Learners started using advanced phrases in place of basic words. The researcher found that a significant growth had been noticed in the language skills of students, vocabulary in particular.

Discussion:

Constructivist Learning Theory

Constructivist theory posits that learners actively construct knowledge through interaction and experience. AI-based tools support this by enabling learners to engage with vocabulary through problem-solving tasks, simulations, and contextualized examples relevant to engineering scenarios.

According to Mayer R. E. (2009), learning is enhanced when information is presented through multiple channels. AI tools often integrate text, visuals, audio, and interactive elements, which support deeper processing and retention of technical vocabulary.

ESP pedagogy emphasizes learner autonomy, as students must continue developing language skills beyond formal instruction. AI-based vocabulary tools promote autonomy by allowing learners to control pace, content, and learning strategies, fostering self-directed learning.

AI-Based Tools for Vocabulary Instruction

AI-driven platforms analyze learners' performance and adjust vocabulary difficulty, frequency, and practice tasks accordingly. This personalization is particularly beneficial for heterogeneous engineering classrooms with varied proficiency levels.

Generative AI tools, such as AI chatbots and writing assistants, can generate discipline-specific examples, explanations, and practice tasks. For engineering students, these tools can contextualize vocabulary within technical descriptions, problem explanations, and project reports.

AI-enhanced corpora and smart dictionaries provide real-time information on word usage, collocations, frequency, and pronunciation, helping students understand how technical terms function in authentic engineering discourse.

Pedagogical Benefits of AI-Based Vocabulary Instruction

AI tools expose learners to vocabulary within authentic engineering texts, such as research abstracts, manuals, and design descriptions, enhancing depth of vocabulary knowledge.

Interactive interfaces, instant feedback, and adaptive challenges increase learner motivation and sustained engagement, which are essential for mastering complex technical vocabulary.

Personalized practice and spaced repetition supported by AI contribute to better retention and transfer of vocabulary to academic writing and oral communication.

Challenges and Limitations

Despite their potential, AI-based vocabulary tools present several challenges:

- Limited access to advanced technology and reliable internet connectivity
- Insufficient digital literacy among teachers and students
- Over reliance on AI tools without pedagogical mediation
- Ethical concerns related to data privacy and academic integrity

Addressing these challenges requires institutional support, teacher training, and clear pedagogical guidelines.

A Proposed ESP-Oriented AI Vocabulary Instruction Framework

This paper proposes a four-stage framework for integrating AI-based vocabulary instruction in engineering ESP courses:

1. **Needs Analysis:** Identification of core academic and technical vocabulary relevant to specific engineering disciplines.
2. **Tool Selection:** Choosing AI tools aligned with learning objectives and learner proficiency.
3. **Task Integration:** Designing ESP tasks such as report writing, problem explanation, and presentations using AI-supported vocabulary input.
4. **Assessment and Feedback:** Using AI analytics and teacher evaluation to monitor vocabulary development.

Implications for ESP Practitioners:

ESP instructors should view AI tools as pedagogical support rather than replacements for teaching. Effective integration requires careful task design, scaffolding, and alignment with course outcomes. Curriculum designers should incorporate AI-based vocabulary components into engineering ESP syllabi to enhance relevance and learner engagement.

Conclusion:

AI-based vocabulary instruction offers significant potential for addressing the specialized language needs of engineering students within an ESP framework. By providing adaptive, contextualized, and learner-centered vocabulary learning experiences, AI tools can enhance technical vocabulary acquisition, motivation, and autonomy. While challenges remain, thoughtful pedagogical integration can maximize the benefits of AI in ESP contexts. Future research should focus on empirical validation of AI-based ESP models and longitudinal studies across engineering disciplines.

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