Exploring Vocabulary Learning Strategies in English for Specific Purposes (ESP): Evidence from Computing Students

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Abstract:

This study investigates the vocabulary learning strategies (VLS) of second- and third-year students of computing in English for specific purposes (ESP) context. The research addressed four research questions: the types and frequency of strategies employed, learners' perceptions of their effectiveness, the role of technology, and the challenges faced in learning technical vocabulary. Data were collected through a survey questionnaire administered via Google Forms. Results indicate a relatively low use of dictionaries and mnemonics, with translation into the mother tongue and guessing from context emerging as dominant strategies. Metacognitive practices such as planning and review were reported at moderate levels, though rarely applied systematically. Students perceived technology-based tools (mobile applications, videos, flash-cards) and contextual learning strategies as most effective, despite not always practicing them consistently. Technology was rated as highly important, yet actual use varied across learners. Reported challenges included memory and retention problems, pronunciation difficulties, and contextual application of terms, alongside affective barriers such as lack of confidence. The study highlights the need for explicit strategy training, structured integration of technology, and increased opportunities for contextualized and communicative vocabulary practice.

Keywords Computing students; English for specific purposes; strategy-training; Technology-enhanced learning; Vocabulary learning strategies

1- INTRODUCTION:

Vocabulary is the cornerstone of any language learning, be it English as a Foreign Language (EFL), English as a Second Language (ESL) or English for Specific Purposes (ESP) context. Without good command of the English vocabulary, students would face many difficulties in performing language tasks, expressing ideas, and interacting with peers using the target language. In ESP domains such as computing, vocabulary plays an even more crucial role because technical terms encapsulate specialized concepts and knowledge structures (Coxhead, 2018). Learners often encounter challenges such as polysemy (e.g., bug, menu, cloud) and the constant evolution of technical lexis which underscore the need for effective strategies to acquire, retain, and apply vocabulary (Hyland & Tse, 2007).

Vocabulary Learning Strategies (VLS) have been defined as the conscious actions or techniques learners employ to discover, consolidate, and use new lexical items (Schmitt, 1997; Oxford, 2003). Several studies suggest that learners, who systematically use a range of strategies, tend to achieve stronger vocabulary growth and retention (Gu & Johnson, 1996; Schmitt, 2010). However, most research has been conducted in EFL or ESL settings, leaving ESP contexts – where learners' professional success depends heavily on mastering technical vocabulary – less extensively studied.

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In recent years, technology has been increasingly integrated into vocabulary learning, ranging from online dictionaries and mobile applications to corpora and spaced-repetition software (Godwin-Jones, 2018; Stockwell, 2016). ESP students in computing are often digitally literate, making them favorable candidates for technology-enhaced vocabulary learning. Yet, existing research suggests that while technological resources are readily available, learners do not always exploit them effectively (Lai & Gu, 2011; Burston, 2015). This highlights the importance of exploring how ESP students perceive and engage with technology in their vocabulary learning.

Despite the availability of various strategies and tools, learners continue to report significant challenges in vocabulary learning. These include difficulty in retaining new terms, confusion caused by the overlap between general and technical meanings, and limited awareness of which strategies to employ in different contexts (Barcoft, 2015; Lessard-Clouston, 2013). Such difficulties may be particularly acute for ESP learners who are rarely provided with explicit training in metacognitive approaches to vocabulary learning (Zhang & Wu, 2009).

To date, relatively few studies have examined the vocabulary learning strategies of ESP learners of computing, despite the centrality of lexical knowledge in this field. Even less is known about how learners evaluate the effectiveness of the strategies they employ, or the extent to wich they view technology as a resource in vocabulary learning. Furthermore, the challenges learners face in mastering computing-related vocabulary remain underexplored. This study seeks to address these gaps by investigating the strategies used by second and third year computing students, their perceived effectiveness, the importance of technology, and the main challenges encountered. Hence, the study raises four main research questions: RQ1. What Vocabulary Learning Strategies (VLS) do second- and third-year computing students report using, and with what frequency? RQ2. How do these students perceive the effectiveness of the vocabulary learning strategies they employ? RQ3. How do students perceive the importance of technology in vocabulary learning, and which technology-mediated strategies are most salient? RQ4. What challenges do ESP computing students encounter in learning and retaining technical vocabulary? Based on our field observation and on the available literature, the following hypotheses are formulated: H1. Learners will report higher use of cognitive and resource-based strategies (for example dictionary use, repetition) compared to metacognitive and social strategies. H2. Learners will perceive metacognitive and deep processing-strategies (for example, using words in context, self monitoring) as more effective than surface level strategies (e.g., rote memorization). H3. Students will rate the importance of technology in vocabulary learning as high, but their reported use of technology-based strategies will show variability.

2- Literature Review:

2.1 Vocabulary Learning in ESP Contexts

Vocabulary occupies a central role in English for specific purposes (ESP) learning, as students must master both the general English lexicon and specialized terminology unique to their field of study (Coxhead, 2000; Nation, 2001). Unlike general English, ESP vocabulary is highly discipline-bound and directly linked to learners' academic and professional success. Research shows that a well developed command of specialized lexis enables students to comprehend disciplinary texts, engage in field-related communication, and participate in professional practices more effectively (Anthony, 2018).

A distinctive challenge in ESP contexts is the prevalence of polysemous items – terms that carry different meanings in everyday English compared to their technical usage. Words such as *chip, bug,* or *network* illustrate how learners may experience confusion when familiar general words acquire domain-specific meanings (Hyland & Tse, 2007). This semantic shift requires learners to develop strategies to move beyond surface memorization and toward a deeper awareness of word meaning in context.

Another complexity lies in the dynamic nature of specialized vocabulary. In fast-evolving domains such as computing and information technology, new terms emerge constantly – examples include *cloud computing*, *deepfake detection* or *algorithmic bias*. Learners must therefore cultivate flexible strategies that allow them to acquire and retain new lexical items efficiently while adapting to ongoing changes to disciplinary discourse (Yang & Coxhead, 2020).

Moreover ESP students often face a mismatch between what is taught in formal classrooms and what is demanded in their academic or professional contexts. Many English programs maintain a strong focus on general English, leaving students underprepared to handle the specialized texts and tasks required in their disciplines (Bocanergra-Valle, 2010; Basturkmen, 2014). This gap reinforces the importance of integrating vocabulary learning strategies tailored to ESP, particularly in domains like computing where technical terminology is dense, highly-specialized, and frequently updated.

2.2. Vocabulary Learning Strategies: Definitions and Classifications

Vocabulary learning strategies (VLS) are generally defined as the techniques or actions that learners employ to acquire, store, and later retrieve new vocabulary items for use in communication. They represent a subset of language learning strategies (LLS) and are considered essential for fostering learners' autonomy and efficiency in vocabulary development. While the concept is widely recognized, scholars have approached the classification of VLS from different theoretical perspectives, resulting in a variety of taxonomies.

Schmitt's (1997) framework remains one of the most influential in the field. He categorizes VLS into five major groups: determination strategies (such as guessing meaning from context or using reference materials), social strategies (interacting with peers or teachers to clarify word meanings), memory strategies (mnemonics, word association, or imagery), cognitive strategies (note-taking, repetition, or word lists), and metacognitive strategies (planning, monitoring, and evaluating one's vocabulary learning). Similarly, Oxford (1990) proposed a broader classification of language learning strategies which also applies to vocabulary learning: memory, cognitive, compensation, metacognitive, affective, and social strategies. Meanwhile, Nation (2001) suggested a more task-oriented model, distinguishing between strategies related to *planning* (deciding what and when to learn), *sources* (identifying where to find the meanings of words, such as dictionaries or corpora), and *process* (techniques for processing and consolidating vocabulary knowledge). These frameworks, though differing in terminology, highlight the multifaceted nature of vocabulary learning and the different dimensions of learner engagement with lexis.

In ESP contexts, the application of VLS may reflect the specific linguistic and professional demands of the discipline. For instance, students of computing or engineering are often encouraged to rely on *determination strategies* (e.g., inferring meaning from technical texts or consulting specialized dictionaries and glossaries) as well as *metacognitive strategies* (e.g., planning for the systematic acquisition of field-specific terminology). Understanding these categories is not only theoretically

important but also practically useful for empirical studies. In the present research, the classification of VLS provided a foundation for the design of the questionnaire, which explored both the types of strategies students use and their perceptions of strategy effectiveness in learning ESP vocabulary.

These classifications illustrate that vocabulary learning strategies encompass a wide range of learner behaviours, from guessing meanings in context to systematically planning and monitoring one's learning. While Schmitt's taxonomy emphasizes strategy diversity, Oxford's highlights both cognitive and affective dimensions, and Nation's focuses more explicitly on planning and sources. Together, these perspectives provide a comprehensive lens through which to understand how learners approach vocabulary learning in general and in specialized domains. In the context of ESP, such classifications are not merely theoretical but serve as a foundation for examining how students actually use strategies and which strategies prove most effective for mastering domain-specific vocabulary.

2.3. Effectiveness and Use of VLS in Previous Research

Previous research on vocabulary learning strategies has consistently shown that learners tend to rely heavily on surface-level strategies such as rote memorization, the use of bilingual dictionaries, and simple repetition. While these strategies are widely used because of their accessibility and immediate results, they are often criticized for their limited long-term effectiveness (Schmitt, 2000; Nation, 2001). In contrast, studies have demonstrated that learners perceive deeper strategies – such as guessing meaning from context, creating word maps, integrating new words into sentences, or practicing vocabulary across different tasks – as more effective for retention and productive use (Gu & Johnson, 1996; Mizumoto & Takeuchi, 2009). This discrepancy between use and perceived usefulness suggests that although learners recognize the value of deep strategies, they often lack the training or motivation to employ them consistently.

A growing body of research also highlights differences in VLS use across variables such as proficiency level, age, and learning context. For instance, more proficient learners are reported to rely on metacognitive and contextual strategies, whereas lower proficiency learners prefer direct translation and memorization (Oxford, 1990; Schmitt, 1997). Similarly, younger learners tend to adopt memory-based strategies, while older or more advanced learners employ metacognitive planning and monitoring strategies (Takac, 2008). Contextual factors also play a significant role: learners in academic or ESP settings often face the dual challenge of mastering general English alongside technical terminology, which complicate their strategy choices (Hyland & Tse, 2007; Coxhead, 2013).

In ESP contexts, particularly in fields such as science, engineering, and computing, students frequently report difficulties in retaining technical vocabulary despite repeated exposure to domain-specific terms (Chung & Nation, 2004; Ward, 2009). This difficuly is often attributed to the abstract nature of specialized terms and the lack of explicit instruction in strategies for handling them. Several researchers argue that without systematic strategy training, learners may remain dependent on rote memorization, which is insufficient for managing the growing lexicon of rapidly developing disciplines (Fan, 2003; Mochizuki, 2005).

Despite the growing literature on VLS in general EFL and academic contexts, a significant gap remains regarding the exploration of strategy use among computing students.

While studies on engineering or science majors exist, research specifically targeting students of computing – a field characterized by constant lexical innovation and heavy reliance on technical terminology – is still limited. Addressing this gap is crucial for understanding how these learners approach vocabulary learning and for identifying the kinds of strategy training that can best support them in mastering both general and specialized vocabulary.

2.4. Technology and Challenges in Vocabulary Learning

The rapid integration of digital technology into education has transformed the ways in which learners engage with vocabulary acquisition. A wide range of digital tools – such as online dictionaries, vocabulary learning applications, corpora, and mobile-assisted platforms like Quizlet – have made vocabulary learning more accessible and autonomous (Godwin-Jones, 2018; Stockwell, 2010). These tools offer features such as immediate feedback, multimodal input (visual, auditory, and contextual), and opportunities for personalized learning. In particular, mobile assisted language learning (MALL) provides learners with anytime-anywhere access, supporting continuous exposure and practice (Burston, 2015).

Technology also facilitates pedagogical practices grounded in effective learning principles, such as spaced repetition systems (SRS), which have been shown to support long-term retention of vocabulary (Nakata, 2011). Additionally, online collaborative spaces, including discussion forums, social media platforms, and classroom learning management systems, provide learners wit opportunities to negociate meaning, share resources, and practice new vocabulary in authentic communicative contexts (Zou & Li, 2015).

Despite these advantages, several challenges remain. Learners often display an overreliance on translation applications, which may limit deeper processing and reduce opportunities for meaningful vocabulary use (Tseng, 2014). Similarly, cognitive overload can occur when students are exposed to too many digital tools or large volumes of input without sufficient guidance (Kukulska-Hulme & Shield, 2008). Research also highlights the difficulty of retaining technical or domain-specific vocabulary, as ESP learners frequently require strategies beyond mere exposure to consolidate disciplinary terminology (Coxhead & Nation, 2001). Moreover, gaps in digital literacy, inconsistent learner motivation, and limited institutional support for technology integration continue to restrict the pedagogical effectiveness of digital tools (Rahimi & Fathi, 2021).

In ESP contexts, the use of technology presents both opportunities and challenges. On the one hand, computing students, being generally tech-savvy, may adapt more easily to digital resources for vocabulary learning. On the other hand, issues such lack of consistency, inadequate strategy training, and potential overload of resources may hinder their ability to use technology effectively for acquiring and retaining specialized vocabulary. These factors suggest that while digital technology offers a powerful avenue for supporting vocabulary learning, it requires careful scaffolding, institutional support, and explicit strategy training to ensure its sustainable and effective use.

3- **Method**:

This section outlines the methodological procedures adopted in the study, including the research design, the instrument employed, the procedures of data collection, and the approach to data analysis. The study aims to investigate the vocabulary learning strategies (VLS) employed by computing students in an ESP context, along with their perceptions of the effectiveness of these strategies, the role of technology, and the challenges they encounter in vocabulary learning.

3.1 Research Design

This study adopted a quantitative survey design, which is commonly used in applied linguistics research to explore learner practices, perceptions, and attitudes on a relatively large scale. A questionnaire was chosen as the main research instrument since it allows for efficient collection of data from multiple participants, ensures anonymity, and provides insights into both the frequency of VLS used and learners' perceptions of their effectiveness in an ESP context.

3.2 Research Instrument(s)

The data were collected through a self administered online questionnaire created using Google Forms. The questionnaire was divided into three sections:

1. *Background information* – demographic details (year of study, gender) and self-assessed English proficiency.
2. *Vocabulary learning strategies* – items that explored the range and frequency of strategies students employ for acquiring, storing, and recalling new vocabulary. The design of these items was informed by established frameworks (Oxford, 1990; Schmitt, 1997; Nation, 2001).
3. *Perceived effectiveness* – items evaluating how effective students consider different strategies for vocabulary learning.

In addition to these sections, the instrument included two open-ended questions. One focused on the role of technology in vocabulary learning, while the other addressed the challenges learners face when acquiring new vocabulary.

3.3 Data collection and Analysis

The questionnaire link was distributed online (through Moodle platform) to undergraduate computing students in their second and third years of study at the Mathematics and Computing department – Ecole Normale Supérieure 'Assia Djebar', Constantine, Algeria. A total of 57 students responded voluntarily to the questionnaire, with 43.2% from second year students, and 56.8% from third year students. The gender distribution showed that 86.5% of the participants were female, while 13.5% were male. Regarding English proficiency, 37.8% self-identified as 'beginners' and 62.2% as 'intermediate' learners, while no student reported an advanced level.

The quantitative data were analysed using descriptive statistics (percentages and frequencies) to indentify patterns in strategy use and perceived effectiveness. Responses to open-ended questions were examined through thematic analysis, allowing recurring themes and insights to be identified and integrated in the discussion.

4-Results:

4.1. Vocabulary Learning Strategies

This section presents the results of the questions related to vocabulary learning strategies (Q4 – Q15). The items were designed to capture the frequency of both metacognitive strategies (planning, evaluating, revising, practicing in context), cognitive strategies (using cards, mnemonics, guessing from contxt, dictionary use, translation), and technology-mediated strategies (mobile apps and online resources). The responses were measured on a five-point Likert scale ranging from *Never (1)* to *Always (5).* A total of 57 students completed this section.

Table 1. Range and Frequency of Employed Strategies

Item	Strategy	1 (Never)	2	3 (Sometimes)	4	5 (Always)
Q4	Planning vocabulary learning	32.4%	16.2%	40.5%	5.4%	5.4%
Q5	Evaluating voabulary learning	29.7%	18.9%	43.2%	5.4%	2.7
Q6	Using cards/notebooks	24.3%	35.1%	27%	8.1%	5.4%
Q7	Practicing in context	13.5%	32.4%	29.7%	10.8%	13.5%
Q8	Using mnemonics	54.1%	16.2%	13.5%	5.4%	10.8%
Q9	Reviewing learned vocabulary	32.4%	29.7%	21.6%	13.5%	2.7%
Q10	Dictionary use	45.9%	29.7%	10.8%	5.4%	8.1%
Q11	Guessing from context	13.5%	13.5%	45.9%	10.8%	16.2%
Q12	Using translation	8.1%	16.2%	32.4%	16.2%	27%
Q13	Transaltion language	Arabic (94.6%), French (2.7), Both (2.7%)	-	-	-	-
Q14	Using mobile apps	8.1%	8.1%	37.8%	18.9%	27%
Q15	Using online resources	24.3%	10.8%	29.7%	10.8%	24.3%

The Source: Produced by the authors

The results show a generally moderate use of metacognitive strategies. Planning (Q4) and Evaluation (Q5) were most often reported as *sometimes* practiced. (40.5% and 43.2% respectively), while regular and systematic planning (‘always’) was rare (5.4%). Reviewing learned vocabulary (Q9) followed a similar trend, with about one-third of students rarely engaging in this practice (32.4%).

Regarding cognitive strategies, dictionary use (Q10) was surprisingly low, with nearly half of the students (45.9%) reporting that they *never* consult a dictionary. Similarly, menemonics (Q8) were the least employed, with more than half of the participants (54.1%) indicating *never*. In contrast, guessing from context (Q11) was a relatively frequent strategy, with 45.9% reporting *sometimes*, and 16.2% *always*. Translation (Q12) emerged as a dominant strategy: over 43% reported frequent or consistent reliance, almost exclusively into Arabic (94.6%).

For technology-based strategies, the results reveal an interesting pattern. Mobile applications (Q14) showed relatively high uptake, with nearly half of the students (46%) reporting frequent to always use, and another 37.8% sometimes. Online resources, such as videos and podcasts (Q15) were used less consistently, with 24.3% *never* using them, while another quarter (24.3%) reported *always* relying on them, suggesting polarization in this practice.

4.2. Perceived Effectiveness

The open-ended responses to the Q16 (which strategies do you find more effective in vocabulary learning?) revealed a wide variety of perceived effective strategies. Students highlighted both traditional and technology-based approaches, with some emphasizing contextualized and repetitive practice, while others stressed the role of multimedia resources and mobile applications.

Table 2. Perceived Effectiveness of the vocabulary learning strategies

Category of strategy	Examples from responses	Frequency (mentions)
Multimedia exposure (videos, movies, YouTube)	'Watching movies' ; 'following YouTube videos' ; 'visual exposure to words'.	12
Contextual learning & use in sentences	'Using new words in real-life contexts' ; 'reveiwing them' ; 'extracting from books, novels'.	11
Mobile apps & digital tools	'Using mobile apps like Duolingo' ; 'vocabulary games' ; 'online flash cards'.	10
Listening & podcasts	'Listening to English songs' ; 'podcasts' ; 'audio-based input'.	5
Note-taking & vocabulary notebooks	'Writing new words in a notebook' ; 'keeping vocabulary cards' ; 'personal word lists'.	5
Reading	'Reading books, novels, stories, articles to discover and retain new vocabulary'.	4
Revision & repetition	'Reviewing vocabulary regularly' ; 'spaced repetition practice'.	3
Dictionary use	'Looking up words in bilingual/monoligual dictionaries'.	3
Speaking & practice	'Using new words in oral communication' ; 'speaking with peers'.	3
Translation	'Translating new words into Arabic/French to check meaning'.	3
Mnemonics & memory aids	'Creating associations or mental images to recall words'.	1

The Source: Produced by the authors

The analysis of students' responses to Q16 revealed a range of strategies perceived as effective for vocabulary learning. As shown in table 2, the most frequently reported strategies were multimedia exposure (e.g., watching movies or YouTube videos, 12 mentions) and contextual learning through use in sentences and real-life situations (11 mentions). Mobile applications and digital tools such as Duolingo or online flashcards were also highlighted by a considerable number of students (10 mentions). Other commonly mentioned strategies included listening activities (songs and podcasts, 5 mentions) and note-taking practices (5 mentions). Less frequently cited, though still present, were strategies such as reading books and articles (4 mentions), revision and repetition (3 mentions), dictionary use (3 mentions), speaking practice (3 mentions), and translation (3 mentions). Mnemonics and memory aids were rarely reported (1 mention). Overall, the responses suggest that students rely heavily on technology-enhanced and context-based approaches, while deeper processing strategies such as mnemonics or active monitoring appear underutilized.

4.4. Importance of Technology in Vocabulary Learning

To explore the role of technology in students' vocabulary learning process, participants were asked to rate the importance of technology on a five-point Likert scale ranging from 1 ('not important at all') to 5 ('very important'). The responses reveal students' attitudes towards technology-mediated vocabulary learning.

Table 3. Perceived importance of Technology in Vocabulary Learning

Rating (1-5)	Percentage (%)
1. not important at all	5.4
2. not important	8.1
3. neutral	13.5
4. important	21.6
5. very important	51.4

The source: Produced by the authors

The results indicate that technology is perceived as a central component of vocabulary learning among the surveyed students. More than half of the respondents (51.4%) rated technology as 'very important', while an additional 21.6% considered it 'important'. Only a small minority regarded it as less significant, with 13.5% selecting a neutral stance, 8.1 choosing 'not important', and 5.4% indicating that technology is 'not important at all'. Overall, these findings underscore a strong reliance on and appreciation of technology in supporting vocabulary learning in the ESP computing context.

4.5. Challenges in Learning English Vocabulary

To gain a deeper understanding of the obstacles that learners encounter in developing their vocabulary, participants were asked an open-ended question about the challenges they face when learning new words. Their responses revealed a wide range of difficulties which were organised thematically to highlight common patterns and recurring issues.

Table 4. Challenges in Vocabulary Learning

Category of Challenge	Examples from Responses	Frequency (mentions)
Memory & retention issues	'forget when I read', 'I find it hard to remeber new words', 'after a while I forget the new words', 'forgetfulness', 'remebering all the new words'	11
Pronunciation difficulties	'pronunciation', 'I have a problem in pronunciation', 'the pronunciation and its meaning'	9
Meaning complexity & usage	'multiple meanings', 'its meaning changes from a culture to another', 'complicity', 'I don't understand some words', 'correct usage in context'	8
Lack of context/exposure	'lack of exposure to native speakers or real-life contexts', 'difficulties in reading novels, then I give up'	4
Affective & psychological barriers	'the courage', 'I can't speak in public because of mistakes', 'communication and speech difficulties'	4
Discipline & motivation	'lack of discipline in the process of learning new vocabulary', 'time'	2
No challenges reported	'at this time, I didn't face any difficulties', 'nothing'	2

The source: Produced by the authors

The results indicate that the most pressing difficulty for participants lies in 'memory and retention problems', reported by 11 respondents, who emphasized the struggle to recall and consistently use newly learned vocabulary. This was followed by pronunciation difficulties (9 mentions), which several learners linked to feelings of insecurity when speaking in public. Similarly, complexity of meaning and correct usage emerged as a recurrent concern (8 mentions), particularly when words carried multiple meanings or required nuanced contextual

application. A smaller number of participants highlighted challenges related to limited exposure to authentic input (4 mentions) and affective barriers, such as lack of confidence in speaking (4 mentions). Less frequently, issues of motivation and discipline (2 mentions) were noted, while 2 respondents mentioned that they did not encounter any significant challenges. These findings suggest that while technical aspects such as memory, pronunciation, and word usage dominate learners' difficulties, affective and motivational factors also play a non-negligeable role.

5-Discussion:

This study investigated the vocabulary learning strategies (VLS) of ESP computing students, their perceptions of effectiveness, the role of technology, and the challenges they face in mastering technical vocabulary. The discussion is structured around the research questions and hypotheses.

Use and Frequency of Vocabulary Learning Strategies (RQ1, H1)

Contrary to the initial hypothesis (H1), dictionary use was surprisingly low, with nearly half of the students reporting that they never consulted a dictionary. Similarly, mnemonics were largely absent from learners' reported practices. Instead, students relied more on translation (mostly into Arabic) and contextual guessing, both of which emerged as dominant strategies. Metacognitive practices such as planning and evaluation were reported at moderate levels, though systematic application was rare. These findings echo earlier reports that learners often favour immediate and accessible strategies (Schmitt, 2000; Zhang & Annual, 2008), but the weak uptake of dictionary use diverges from some previous ESP research (Nation, 2013) where dictionaries were a cornerstone strategy. This discrepancy may reflect both learners' reliance on translation and the growing availability of quick digital alternatives.

Perceived Effectiveness of Strategies (RQ2, H2)

When asked about effective strategies, students highlighted technology-based resources (multimedia, mobile apps, flashcards) and contextual learning (using words in sentences, exposure through real-life input). Traditional strategies such as note-taking, repetition, and dictionary use were mentioned less frequently. This partially supported H2, since contextual and deeper processing strategies were indeed valued, though not consistently practiced. The gap between what the learners 'do' (translation and guessing) and what they value (multimedia, context-based use) suggest a lack of alignment between practice and perceived effectiveness, a mismatch also identified by Oxford (2017). It underscores the need for explicit strategy training to help learners adopt and consistently apply the strategies they themselves view as most beneficial.

Technology-mediated Vocabulary Learning (RQ3, H3)

Technology was rated very important by the majority of students, confirming H3 in terms of attitudes. Reported practices, however, revealed variability: while mobile applications enjoyed relatively high and consistent use, other resources such as online videos and podcasts showed a polirized pattern (some students always use them, others never do). This echoes Stockwell (2012) and Gowin-Jones (2018), who highlight both the potential of digital tools and the uneven uptake depending on learners' preferences, digital literacy, or training. For ESP teaching, this suggests that integrating structured digital tasks into course work may help normalize and stabilize learners' use of technology for vocabulary learning.

Challenges in Learning Technical Vocabulary (RQ4)

Students most often cited memory and retention difficulties, followed by pronunciation issues and problems with nuanced usage of terms. These findings align with Ward (2009) and Coxhead (2018), who note the persistence of technical retention problems in ESP contexts. Interestingly, affective challenges such as insecurity in speaking and lack of confidence were also noted, albeit less frequently. This highlights that vocabulary learning in ESP is not only cognitive but also a socio-affective process, requiring opportunities for meaningful oral practice.

Overall, the findings point to four main trends:

1. A reliance on translation and guessing rather than dictionaries and mnemonics diverging from expected patterns.
2. A mismatch between reported practices (translation, repetition) and perceived effectiveness (contextual, technology-based strategies).
3. High appreciation for technology, but uneven integration across tools.
4. Persistent challenges with memory, pronunciation, and contextual usage, compounded by affective barriers.

These insights suggest that ESP learners need structured pedagogical support not only vocabulary strategy use but also in the integration of digital and communicative practices.

5- Conclusion and Recommendations:

This study set out to explore the vocabulary learning strategies (VLS) used by second- and third-year computing students in an ESP context, their perceptions of effectiveness, the role of technology, and the challenges they face in acquiring technical vocabulary. The findings indicate that while learners report some use of metacognitive strategies such as planning and evaluation, these are not applied systematically. Dictionary consultaion and mnemonics, often assumed to be central to vocabulary learning, were surprisingly infrequent, whereas translation into the mother tongue and guessing from context emerged as the most common practices. Learners, nevertheless, perceived technology-based tools – such as mobile applications, flashcards, and multimedia resources – and contextual approaches, such as using words in sentences and real-life situations, as particularly effective for long-term retention. Technology was rated as highly important by the majority, tough its actual integration into learning practices was inconsistent. Students also reported persistent challenges, notably difficulties with memory and retention, pronunciation, and the nuanced use of technical terms, along with affective barriers such as insecurity in speaking.

These findings suggest several implications for ESP teaching. Raising learners' awareness of the relative effectiveness of different strategies is essential, particularly in encouraging them to move beyond reliance on translation towards more contextualized and communicative use of vocabulary. Greater emphasis should be placed on metacognitive awareness, helping learners to plan, monitor, and evaluate their vocabulary learning systematically. Technology, while valued, requires more structured integration into coursework to ensure that digital tools are used strategically rather than occasionally. Addressing pronunciation and retention through recycling activities and oral practice is equally important, especially to build students' confidence in applying technical terms. Finally, bridging the gap between general English proficiency and specialized vocabulary can enhance learners' ability to use

computing terminology accurately and effectively. Taken together, these recommendations underscore the need for a pedagogy that combines strategy training, contextualized practice, and technology-enhaced learning to support the vocabulary development of ESP computing students.

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