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Demographic patterns in technical vocabulary acquisition and retention strategies among ESL engineering students in India

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ABSTRACT

Technical vocabulary, the domain-specific terms, is central to ESL engineering students' access to disciplinary knowledge. This study investigates the range and interaction of Technical Vocabulary Acquisition and Retention Strategies (TVARSs) employed by ESL engineering undergraduates in Tamil Nadu, India. Forty strategies divided into 11 categories were examined with attention to patterns of use and learner rationales. Using a mixed-methods design, data were collected from 331 undergraduate engineering students from rural, semi-urban, and urban backgrounds through a structured questionnaire and semi-structured interviews. Descriptive, correlational, and network-based modelling analyses were done. Findings reveal that technical vocabulary acquisition operates as a networked system of interrelated strategies rather than isolated practices. Major strategies provide structural support for vocabulary acquisition, while low-frequency strategies help as connectors that enhance adaptability, transferability, and learning resilience across demographic contexts. Network analysis further demonstrates that effective vocabulary development depends more on strategic coordination than on the frequency of individual strategies. The study identifies demographic variation in strategy access linked to learning environments and technological resources, and argues for demographic-responsive instruction that strengthens core strategies, promotes integrative connector strategies, and supports equitable access to reflective and technology-assisted learning practices.

KEYWORDS: vocabulary acquisition and retention strategies, technical vocabulary, demographic, English as a Second Language (ESL), engineering education, ELT

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1. Introduction

To learn a language, vocabulary acquisition and retention are the rudimentary steps in using the language successfully. Numerous studies have been carried out on different Vocabulary Learning Strategies (VLS) (Jayachandran et al., 2025; Nation et al., 2001; Jones and Durrant, 2010; Wanpen et al., 2013; Ghalebi et al., 2020), the results of which are beneficial to teachers and learners in the educational process (Hoang, 2018). Lack of vocabulary is one of the most significant issues that any learner faces in acquiring a new language within the framework of ESP (Jones and Durrant, 2010; Bashori, M., 2021; Mon, A. M. et al., 2025). Determining the VLS that is followed by the English as a Second Language (ESL) engineering students would allow teachers to offer effective classroom interventions and vocabulary learning results. The existing literature suggests that factors such as individual learning style, cognitive capabilities, and external influences, including teaching methods, available technologies, and the amount of exposure to the target language, determine the use of select strategies (Duong, T.M., 2022). Domain-specific technical vocabulary needs specialised strategies for effective acquisition and retention by ESL engineering students. Thus, understanding the factors that define the Technical Vocabulary Acquisition and Retention Strategies (TVARSs) of ESL engineering students would give a clearer understanding of the effective teaching and learning interventions.

In the context of ESL, engineering students often struggle to master their domain-specific technical vocabulary (Nation, 2001). Awareness of vocabulary acquisition strategies and proper training to utilise them produces remarkable improvements in learners' vocabulary knowledge and enhanced learning outcomes (Ayana et al., 2024). The growing attention to technical vocabulary instruction in the engineering curriculum, which addresses demographic differences in vocabulary acquisition strategies among engineering undergraduates, remains limited. Urban, semi-urban, and rural learners have different exposure levels to English input, pedagogical environments and technological access, which may influence both the acquisition and retention of technical vocabulary.

Therefore, this study aims to a) identify the predominant strategies used by ESL engineering students to acquire and retain technical vocabulary, b) examine the preference variation across demographic categories, and c) interpret how contextual factors and demographics mediate learners' strategic orientations.

2. Literature Review

The academic proficiency of the ESL engineering students is determined by the amount of acquisition and retention of technical vocabulary (Hyland & TSE, 2007; Coxhead, 2017; Saeedi, & Najjarpour, 2024) of the learners especially in the disciplines of Science, Technology, Engineering and Mathematics (STEM) because the ability to master specialised academic language is an important requisite for professional success (Jantassova, 2024; Topliceanu et al., 2025). The mastery of the technical vocabulary ensures both conceptual comprehension and disciplinary identity for the students learning through ESL. In multilingual contexts like India, learners' transition into engineering education is from varied schooling and demographic backgrounds; therefore, vocabulary learning becomes not only a cognitive task but also a sociolinguistic negotiation of access to academic discourse (Jayachandran & Madhavi, 2025; Sarma, 2025; Nation, 2013; Ferguson, 2007). The advancement of science and technology has led to the widespread use of technical vocabulary in the workplace and in specialised fields. Nowadays, interdisciplinary and integrated study programmes encourage teachers and learners to focus on acquiring technical vocabulary regardless of their specialisation (Gomathi & Senthamarai, 2024).

Technical vocabulary is sometimes an ordinary word that becomes technical when it denotes a specific meaning in a particular domain, which differs from its lexical meaning (Aleshchanova et al., 2020; Nation & Newton, 1997). The difficulty and specificity of domain-specific terms pose unique challenges for ESL learners in learning and retaining technical vocabulary. However, the learning and retention of vocabulary strategies by ESL engineering students is underexplored. Technical vocabulary learning is quite challenging and different from general vocabulary learning for the following reasons: i. Context-specific, ii. Same word with different meanings, and iii. Interdisciplinary. ESL engineering students often struggle to comprehend, retain and apply technical vocabulary in academic and professional contexts (Mohammadi et al., 2024; Pellicer-Sánchez, 2020; Nation, 2013). Therefore, it is essential to identify effective strategies for technical vocabulary acquisition and to enhance the academic success of ESL engineering students.

In engineering education, technical terms are vital not only for reading textbooks and academic papers

but also for processing lectures, writing reports, and participating in disciplinary discourse (Liu, 2023; Hyland, 2009; Coxhead, 2017). Unlike general vocabulary, technical terms are often low in frequency in general corpora but high in specificity and density within a subject area, making them difficult to acquire incidentally through everyday exposure (Reynolds et al., 2023; Nation, 2001). Engineering students must therefore confront complex and abstract terminology, which is often morphologically derived from Latin or Greek roots and used in syntactically dense academic registers (Crosson, A. C. et al., 2024; Wing Yee Siu, 2024; Biber et al., 2007).
Vocabulary learning strategies (VLS) refer to the deliberate and conscious actions learners take to acquire, retain, and retrieve word meanings (Alahmadi, A., & Foltz, A., 2020; Aljasir, N., 2025; Schmitt, 1997; Gu & Johnson, 1996). Building on the cognitive theory of learning, VLS research has categorised strategies into various taxonomies. Schmitt's (1997) seminal taxonomy divides strategies into five broad categories: Determination (discovery of meaning), Social (interaction-based learning), Memory (mnemonics and associations), Cognitive (mechanical processes), and Metacognitive (planning and monitoring). Similarly, Nation (2001) classifies strategies into three stages: planning, sources, and processes. He also emphasises the distinction between receptive and productive vocabulary knowledge.

Later researchers have elaborated on these classifications by highlighting the depth of processing (Craik & Lockhart, 1972), learner autonomy, and the socio-affective dimensions of language learning (Vellanki et al, 2024; Oxford, 2011). Strategies such as repetition, semantic mapping, keyword technique, and imagery have been used to enhance memory and to promote better retention (Lasekan, 2025; Mettewie, 2024; Cohen & Aphek, 1981). Cognitive strategies, such as note-taking, word grouping or association, and contextual guessing, are often preferred by more proficient learners. Self-assessment and spaced retrieval are associated with metacognitive strategies that can be employed to enhance long-term retention and promote learner autonomy. However, all the available literature has mostly discussed general or academic vocabulary in EFL situations, thereby overlooking the particular needs of technical vocabulary acquisition in content-based instruction. In addition, the connection between demographic variables and strategic behaviour is not fully explored, especially in those underrepresented regions and disciplines, such as engineering (Aljasir, N., 2025; Zhou, W., & Wu, X., 2024; Gu, 2003). In assignments where engineering students were required to use technical English words, researchers found that there were considerable difficulties related not only to the lack of prior knowledge but also to the language environment in which they were taught. Amel (2021) highlighted practical tasks, namely matching, classifying, and situational inquiry, to support learning technical terms and recommended combining different pedagogical tasks into the ESP programmes to support ESL engineering students.

A study by an empirical researcher, who followed 150 engineering undergraduates at ENSAM, Meknes, on their vocabulary learning strategies (VLS) was conducted within the framework of learning technical terminology. Findings revealed that dictionary consultation and inferencing were important predictors of high performance in technical vocabulary, accounting for 30% of the variance in performance scores. It suggests targeted strategy instruction to improve technical vocabulary learning in engineering curricula (Elkhadiri, 2025). While acquisition refers to the initial learning of vocabulary, retention concerns the durability and accessibility of lexical knowledge over time. Vocabulary retention has been shown to depend heavily on frequency of exposure, depth of processing, and strategic engagement (Sahin D & Yavuz MA., 2025; Uchihara, T. et al., 2023; Nation & Webb, 2011). Numerous studies affirm that strategies promoting elaboration, such as generating examples, using new words in context, and teaching others, lead to better long-term retention than rote memorisation alone (Chung, E., 2025; Barcroft, 2009).

Spaced repetition, visual encoding, and learner-generated associations have also been positively correlated with improved recall (Baddeley, 1990; Webb, 2007; Pickering, H. E.et al., 2023). Yet, in technical education, where the pace of content delivery is rapid and the vocabulary load is high, learners may not receive adequate support in strategy use or sufficient opportunities for recycling. Therefore, understanding which strategies ESL engineering students use and which they perceive as the most effective is overlooked in curriculum design.
Learners with higher proficiency levels tend to employ more complex processing strategies, while learners with weaker backgrounds rely more on rote methods. Similarly, females have been shown in some studies to use a wider range of strategies and to engage more with metacognitive planning than males (Zarrati, Z, 2023; Gu & Johnson,1996; Green & Oxford, 1995).

The rural-urban divide is particularly pronounced in the context of multilingual settings such as India,

where the disparate access to exposure to the English language and the quality of instruction trigger inequalities. Students from rural origins and vernacular-medium schools faced increased difficulty as their lexical repertoires are limited, and they have poor awareness of strategies. First-generation learners who are often denied a strong home-based academic scaffold might also struggle to apply the learning strategy to different discipline fields, thus hindering their vocabulary retention ability. The question of the intersection of such demographic variables with the use of vocabulary learning strategies in ESP or technical education has rarely been directly questioned in empirical studies in the Indian milieu. Although some studies have established a difference in proficiency between rural and urban learners, the majority have not attributed the differences to differences in strategy utilisation or retention. This, in turn, creates a strong demand for fine-grained and situation-specific studies which are sensitive to the differences in demographics as an inherent determinant of language-learning behaviour and not a marginal factor.

3. Data Collection and Methodology

The current study follows a convergent parallel mixed-methods design (Creswell & Plano Clark, 2018), and thus, the study combines quantitative and qualitative databases to provide a full analysis of technical vocabulary acquisition and retention mechanisms among ESL engineering learners. The quantitative strand deals with a structured survey, and the qualitative strand deals with a semi-structured interview. The mix of methods is explained by the complexity of the research questions that require the breadth, or strategic utilisation, in the whole range of the demographic spectrum, and the depth, or understanding of the personal perceptions and experiences. This design makes triangulation as well as validating findings easier, and exploring convergence and divergence between self-reported behaviours and real learner insights.

3.1. Research Context and Participants

The study was conducted in the context of higher education in India, where a sample of 331 first-year undergraduate engineering students from an engineering college located in Chennai, Tamil Nadu, India, in the academic year 2024-2025. The number of respondents to the structured quantitative survey was 331, and among them, 60 selected students (20 each of the demographic factors) participated in the semi-structured interview. The participants were from various streams of engineering: Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Science Engineering, Electrical and Electronics Engineering, Electronics and Communication Engineering, Information Technology, and Mechanical Engineering. This rate of inclusion in diverse academic streams was to make sure that there was a variation in disciplinary and language proficiency, as well as exposure to technical vocabulary. The demographic data collected include gender, branch of engineering, region of origin (rural, semi-urban, urban), first-generation learner status, first language (L1), and medium of instruction at the higher secondary level. This information facilitated a demographic segmentation of strategy use and perception patterns. Table 1 provides the divergence of participants in the survey and the semi-structured interview, along with their demographics.

Table 1. Variables and Group Classification of the Participants

Variable	Group	Participants	Percentage %
Gender	Male	178	53.78
	Female	153	46.22
Engineering Branch	Chemical	7	2.11
	Civil	9	2.72
	Computer Science	71	21.45
	Electronics & Communication	84	25.38
	Electrical & Electronics	48	14.50
	Bio-Medical	12	3.63
	Information Technology	64	19.34
	Mechanical	36	10.88

Demographics	Urban	153	46.22
	Semi-urban	95	28.70
	Rural	83	25.08
Participation	Survey	331	100.00
	Questionnaire	60	18.13
N = 331			

3.2. Research Instruments

Two research instruments, namely a structured questionnaire and a semi-structured interview, were used to collect data.

3.2.1. Survey Questionnaire: The structured questionnaire was designed using Google Forms and has two parts:

3.2.1.1. Part I – Demographic Profile: This section collects the basic essential details such as Name (to track the interview follow-ups), Gender, Academic Branch, Region of Origin (demographics categorised as rural, semi-urban, urban), L1, and Medium of Instruction at the higher secondary level.

3.2.1.2. Part II – TVARS Survey Questionnaire: This part of the questionnaire has 40 closed-ended TVARSs under 11 categories, and is incorporated under 11 sections in Google Form. These 40 widely used TVARS are derived from Schmitt's (1997) and Nation's (2022) taxonomies; among them, some are added due to the advancement of science and technology, and the emergence of AI into the list and grouped under 11 categories, which can be observed in the Table. 2. Each strategy was rated on a five-point Likert scale ranging from "Never" (1) to "Always" (5), allowing the measurement of frequency and preference. The instrument was tested with a pilot study, and a high Cronbach's Alpha (0.932) suggests that the questionnaire is a reliable tool, and the variance analysis of individual items indicates a balanced spread of responses, ensuring that no single item disproportionately affects reliability.

Table 2. Technical Vocabulary Acquisition and Retention Strategies (TVARS)

S. No	Technical Vocabulary Acquisition and Retention Strategies (TVARS)
1. Determination Strategies	
S1	Using a dictionary (English to English, English to other regional languages) to learn new words.
S2	Guessing the meaning of unfamiliar words by analysing their prefixes, suffixes, or roots.
S3	Looking for context clues (finding meanings of the words based on the context they are used in sentences) and associated words to get the meaning of the new word.
2. Social Strategies	
S4	Working with my peers in group activities to learn new vocabulary.
S5	Discuss new words with classmates to reinforce the words.
S6	Group projects and assignments help to learn new words by collaborating with peers.
S7	learn vocabulary by collaborating with students from other states and countries.
S8	Seeking peers and teachers to note and comment on vocabulary.
3. Memory Strategies – Repetition	
S9	Repeating new words in various contexts to understand and retain (remember) them.
S10	Using flashcards to review vocabulary regularly.
S11	Associating new words with something familiar to help remember them.
4. Memory Strategies – Mnemonic	
S12	Creating mental images to remember new words.
S13	Using acronyms or abbreviations to remember vocabulary. (e.g., ATM for Automatic Teller Machine, AI for Artificial Intelligence, and so on)
S14	Making rhymes or songs to help remember new words.
S15	Using keywords from my native language to remember new words.
5. Memory Strategies - Semantic Mapping	
S16	Creating mind maps or diagrams to connect new words with related words.

S17	Making word webs to learn synonyms, antonyms, or related words.
S18	Learning vocabulary by focusing on common word combinations (collocations). (e.g., Make a decision, strongly agree, highly satisfied and so on.)
S19	Associating words with their word families (e.g., Software Developer, Software Engineer, Software Architecture) to expand vocabulary.
6. Cognitive Strategies - Contextual Learning	
S20	learning vocabulary by identifying it in reading materials (books, novels, newspapers, articles, etc.).
S21	Learning vocabulary by listening to lectures or podcasts in English.
S22	Using new words in various contexts to understand and remember their meaning.
S23	Guessing the meanings of new words based on the context in which they are used in sentences.
7. Active Engagement Strategies	
S24	Having a vocabulary journal (a notebook or a Word document where we make notes of new words) to track new words and their meanings.
S25	Playing vocabulary games (crosswords, word search, etc.) to practice words.
8. Technology-Assisted Learning Strategies	
S26	Using language learning apps (e.g., Duolingo, Memrise) to practice vocabulary.
S27	Using online dictionaries or thesauruses to understand new words.
S28	Listening to English songs and podcasts to learn new words.
S29	Reading e-books or listening to audiobooks to improve my vocabulary.
S30	Replace unfamiliar words with familiar synonyms I already know.
9. Metacognitive Strategies	
S31	Monitor my vocabulary learning progress and identify the areas for improvement.
S32	Reflecting on the vocabulary-learning strategies that work best to learn and retain vocabulary.
S33	Organising vocabulary study by themes or difficulty levels.
10. Task-based & output-based strategies	
S34	Learning vocabulary by engaging in real-world tasks, such as making presentations, negotiating with people, Role-playing, web quests and so on.
S35	Actively using new vocabulary in speaking exercises or conversations.
S36	Learning and practising new vocabulary while writing assignments and participating in classroom activities.
Category 11: Motivational Strategies	
S37	Setting specific goals for learning new vocabulary (e.g., learning 10 new words a day).
S38	Rewarding yourself when you reach your vocabulary learning goals.
S39	Keeping a positive mindset and tracking progress when learning vocabulary.
S40	Participating in word-related competitions to learn, recall, and retain vocabulary.

3.2.2. Semi-Structured Interview

A semi-structured one-on-one interview was conducted with the selected 60 (n=60) participants from the sample, spanning 20 from each region of origin (rural, semi-urban, urban) for qualitative analysis. The interviews were guided by three primary questions:

1. What challenges do you face while learning or remembering technical vocabulary?
2. Which strategies or practices do you find most helpful in learning technical vocabulary?
3. What resources (teachers, books, tools, digital media) help you improve your technical vocabulary?

Probing questions were used to elicit elaboration and clarification. The interviews were conducted bi-lingually based on students' comfort.

3.3. Reliability of the Instrument

Before conducting substantive analyses, the internal consistency of the 40-item instrument was examined using

Cronbach's α (alpha) and McDonald's ω (omega). Cronbach's α assumes tau-equivalence across items, while McDonald's ω accounts for differential item loadings, offering a more robust estimate of reliability when the assumption of equal contributions is violated. These two indices showed that the instrument was very reliable as it accurately represented the construct of vocabulary learning and retention strategies. Table 1 summarises the results.

Reliability Index	Value	Interpretation
Cronbach's α	0.92*	Excellent internal consistency
McDonald's ω	0.94*	Strong reliability with heterogeneity

Table 3. Internal Consistency of the Survey Instrument

3.4. Data Collection Procedure

Participants were informed about the purpose, procedure and steps involved in the study. Ethical Clearance was obtained from the institutional research ethics committee. Participants were informed of their right to withdraw at any point. Assured of confidentiality, and collecting informed consent forms were collected. All data obtained was anonymised and securely stored. The survey questionnaire was administered, after getting voluntary consent from the participants, in the language lab during regular English Classes. Each session was preceded by a brief explanation of the research purpose and assurances of ethical conduct. Students completed the survey anonymously in approximately 20 to 30 minutes. Responses were collected digitally using Google Forms for standardisation and ease of analysis.

The semi-structured interviews were conducted in dedicated sessions, bi-lingually, if needed. The data were recorded and later transcribed and validated to be used in thematic interpretation.

4. Results and Discussion

To explore the vocabulary acquisition strategies, a set of analytical tools has been used to examine the different strategies in terms of three major dimensions, namely perceived importance of each strategy, frequency of the strategy usage, and interrelationship of the strategies. Python was chosen as the analytical platform because it is characterised by strong features in the processing of numerical data, and its ability to produce accurate and quality visual displays. The libraries *Pandas, Networkx, matplotlib*, and *seaborn* have been selected as they have powerful features of efficient data processing and offer high-quality visualisation, such as network graphs and heatmaps. A *library* is a prewritten set of modules, functions and tools in the Python programming language which offers specialised data processing, analysis and visualisation.

The *pandas* library played a key role in organising and pre-processing the dataset, which consisted of learners' responses for the 40 different strategies in the rural, semi-urban, and urban settings. The network models were developed and analysed using *Networkx* since it has the capability of modelling weighted relationships, central strategy identification, and layout optimisation on similarity networks with complex networks. To visualise the results, coherent colour schemes have been used, and to improve the overall interpretability and aesthetic value of the graphical outputs, Matplotlib and seaborn were used.

4.1. Descriptive Analysis of Strategy Use

The data set consists of responses of 331 engineering students from rural, semi-urban and urban settings. Descriptive statistics revealed differences when it comes to adoption patterns between demographic groups: The said traditional and peer-assisted strategies, such as the use of dictionaries (S1), group work (S4-S6), and repetition (S9), were mostly used by the rural students. The urban students achieved higher scores in the utilisation of technology-assisted (S26-S30) and metacognitive (S31-S33) strategies, which demonstrated higher self-regulation and accessibility to online means. Semi-urban students had an intermediate response as they were able to combine traditional and digital behaviours and tended to have higher mean scores in most strategies, implying a holistic nature of learning orientation.

4.3. Heat Map of Strategy Preferences

To represent demographic differences, a heat map was created to show the mean usage of each 40 strategies of 3 groups (Figure 1). The heat map revealed that rural students demonstrated also the focused intonation of associative and repetition-oriented strategies (S1, S4, S9), which supports their approach to the recognition of

traditional, practice-based methods.

The urban learners had more acute peaks in a few of the high-impact strategies in technology-assisted and metacognitive areas (S26-S33) and a reduction in the intensity in peripheral strategies. Semi-urban students showed wider and more equal distribution of the strategy use with a comparatively higher level of adoption in nearly all the categories, which can be attributed to the integration of both the traditional and modern practices. This finding highlights the contextual power of demographic settings on strategic preference, where semi-urban students show flexibility in modalities. This distribution underscores the contextual influence of demographic environments on strategic preference, with semi-urban students demonstrating adaptability across modalities.

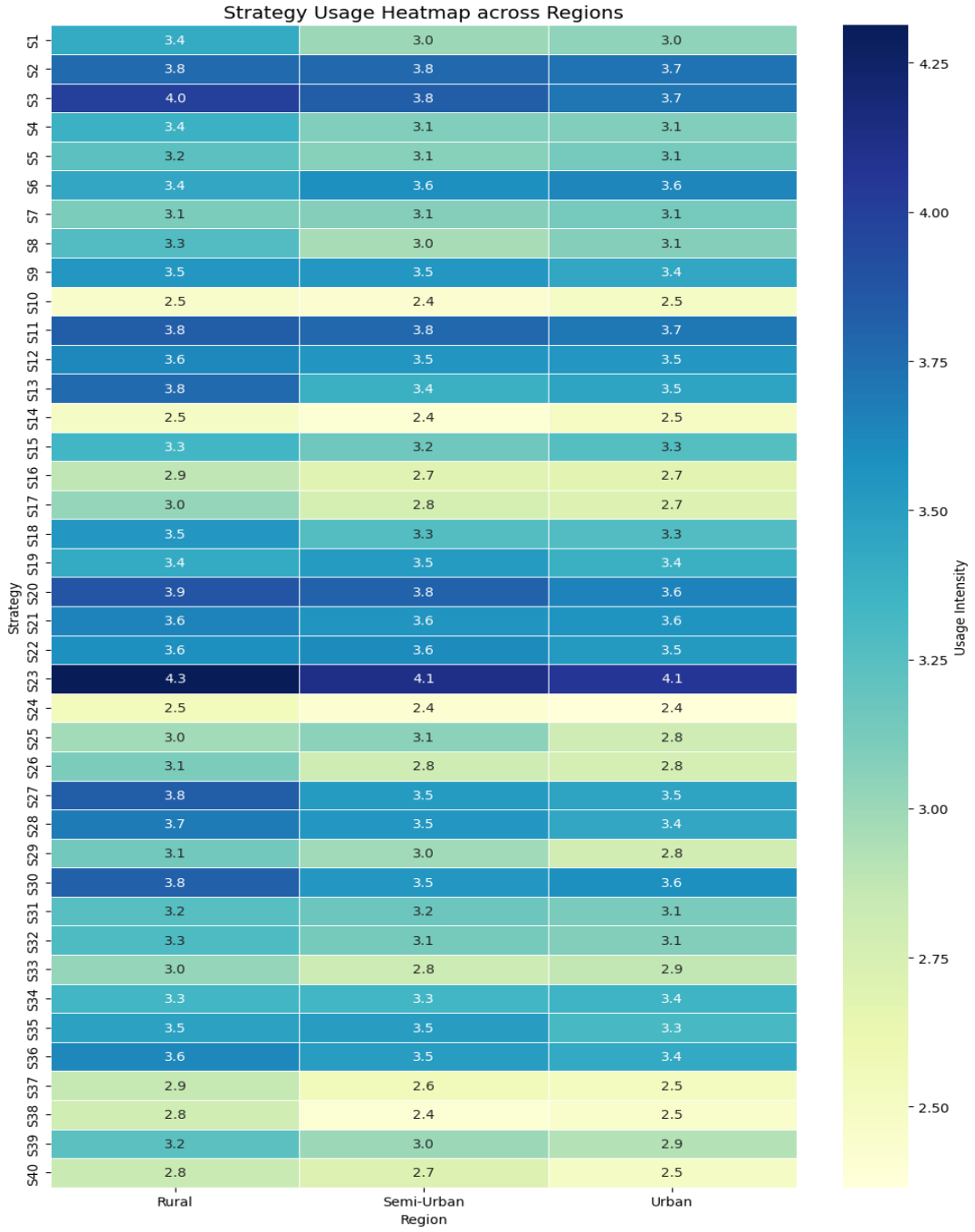

Figure 1. Heat map of strategy adoption across demographic groups

Note: Darker shades indicate higher mean usage scores for each strategy.

4.4. Network Analysis of Strategy Interconnections

A network diagram has been mapped to study the structural relationship between the strategies (Figure 2). Nodes are the strategies (S1-S40), node size is the centrality and edge thickness is the strength of similarity or co-occurrence. The network analysis showed that the network has a dual structure: Core Hubs: The strategies are S1 (Dictionary use), S3 (Context guessing), S9 (Repetition), S23 (Association-based recall), and S35 (Application

in speaking/writing) which had several robust edges across clusters but were placed at the periphery. This implies that they are high-frequency, specialised strategies, which are adopted universally but that are not very integrative. Connector Strategies: Similar strategies like S14 (Rhymes/Mnemonics), S16 (Mind maps/Diagrams), and S31 (Reflection on strategy use) were found towards the network centre with several bridging ties. Limited in use, these strategies were structural bridges, making movement between otherwise discrete clusters possible and encouraging strategic diversity. This difference shows that successful acquisition of vocabulary does not merely rely only on reinforcing high-frequency strategies but also using connector strategies to expand the adaptive abilities of learners.

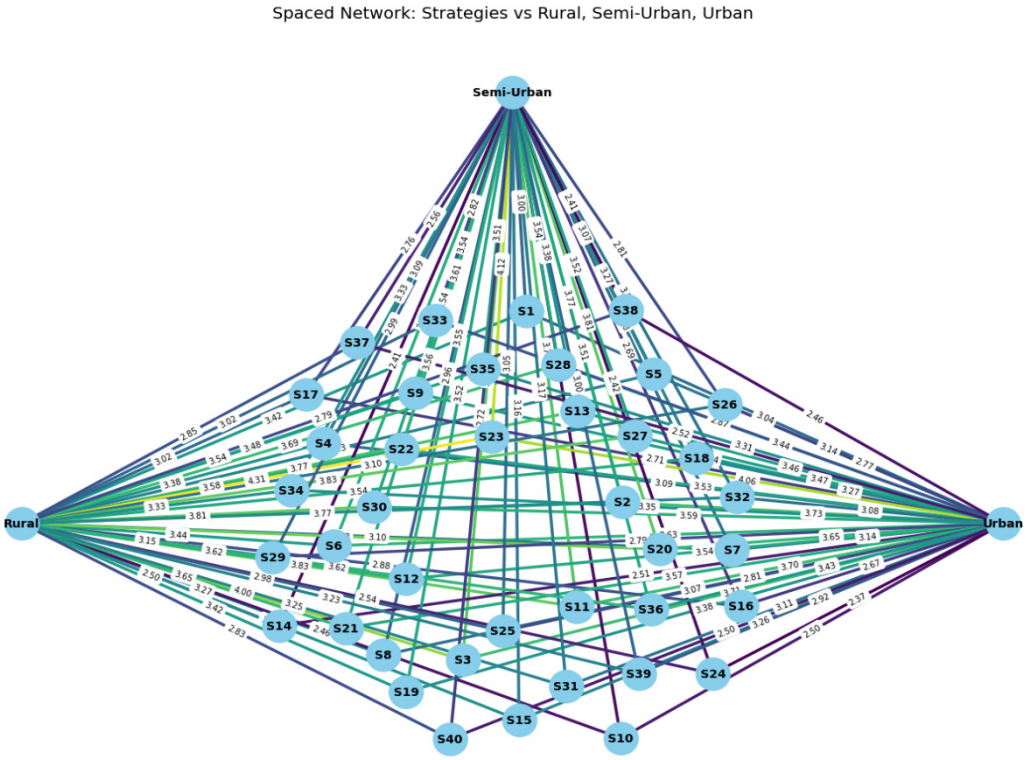

Figure 2. Network diagram of inter-strategy relationships

Note: Node size represents centrality; edge thickness indicates similarity score. Peripheral nodes (e.g., S1, S9, S35) denote high-frequency strategies, while central nodes (e.g., S14, S16, S31) denote connector strategies.

4.5. Pedagogical Implications

The results indicate the presence of a two-level pedagogical framework: Widening of high frequency strategies (ex: S1, S9, S35) that are reliable across demographics. Connections (e.g., S14, S16, S31) to increase strategic flexibility and adaptability should be propagated. Interventions need to be tailored to differences in the context: Improving rural learner access to and digital literacy. Enhancing the relationships of teamwork and communication within the urban learners. Integrating balanced and hybrid solutions to semi-urban students.
The results of this research have a great implication on teaching of English language to engineering students. The difference in vocabulary acquisition strategies between the rural, semi-urban and urban learners indicates that one must have different instructional strategies. Teachers are motivated to use context sensitive pedagogy that is accommodating of various language forms and strategic preferences of the learners. In the case of rural learners, who might be more dependent on rote memorisation, or translation-based approaches, teaching should be focused on contextualised vocabulary application in terms of task-based, and communicative exercises that will contribute to more lexical processing.

Strategy training modules can be offered to semi-urban learners who tend to follow a balanced approach in the strategy and metacognitive strategies so that they can develop self-regulation of vocabulary learning. Social and metacognitive approaches are especially favoured by urban learners, and these can be extended to the collaborative learning settings and project-based activities that would allow them to develop vocabulary independently and with the help of peers. Also, explicit teaching of strategies in the ESL curriculum can result in students being able to choose and implement strategies applicable to particular learning situations in a

conscious manner.

The teachers are expected to capitalise on technology-based vocabulary aids, including mobile applications or web-based corpus to eliminate the differences in exposure among demographics. In general, a deliberate and thorough method may be used to improve the acquisition and maintenance of technical vocabulary among engineering students, which will further lead to better academic and professional language proficiency in the latter.

4.6. Summary of Findings

It is shown in the analysis that technical vocabulary learning can best be viewed as a net of interdependent strategies, but not as a set of separate methods. Although core strategies are a source of fundamental stability, connector strategies are essential in increasing adaptability and transferability. Furthermore, the heat map highlights the demographic differences in preference strength, whereas the network diagram sheds light on structural interdependence. Combined, these results support the notion that pedagogical interventions are not only expected to strengthen already existing strategies but also intentionally develop the relatively underused connectors and result in more robust and multifaceted vocabulary acquisition.

5. Conclusion

This work gave a detailed analysis of vocabulary learning strategies in engineering students grouped in terms of the demographics - rural, semi-urban and urban using a combination of descriptive, correlational and network analysis methods. The results showed that the strategic preferences of the learners are highly dependent on their learning environments and access to resources. Although the rural learners were more dependent on old-fashioned and practice-based methods, the urban learners were more dependent on technology-based and metacognitive methods, since they had more freedom and easy access to digital information. A balanced and integrative approach to the use of strategies was observed among semi-urban learners, indicating that the tactics were flexible to utilise both traditional and contemporary learning skills.

The network could further enlighten the latent structure of strategy use, as the two important kinds of strategies, high-frequency, core strategies and structurally significant connector strategies were also distinguished. Core strategies were popular among groups but operated mostly within particular spheres of practice, whereas connector strategies, though not as popular, had a decisive role in connecting divergent learning strategies. This structural observation shows that the proper development of vocabulary does not solely lie in the frequency of use of a strategy, but also in the comprehensive development of learners in using and coordinating the various strategies to enhance deeper learning.

As a pedagogical point, the research highlights the importance of demographic-sensitive and inclusive teaching of vocabulary in engineering education. The teachers should also strengthen strategies that are universal, but encourage the use of connector strategies that encourage flexibility and integration of the strategies. Adjusted interventions are needed to increase the digital access of rural learners, foster reflective awareness of semi-urban learners, and enhance collaboration in urban learners. With the incorporation of clear strategy teaching and the use of technology-enhanced technologies, a teacher can promote more equitable and efficient vocabulary learning results, which ultimately will help students learn and use vocabulary in language and acquire proficiency in its use.

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Authorship and Level of Contribution:

1. This paper is collaboratively written by V. Sabarethinam and Dr. D. Praveen Sam. They have together carried out discussions and formulated ideas for the study. Moreover, they have prepared and revised the questionnaire, conducted the survey, collected and interpreted the data, and drafted this article.
2. Dr. A. Vijaya Lakshmi and Dr. R. Rajmohan processed the data, prepared the heat map and Network analysis based on the data curated.

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