LOST IN TRANSLATION? EXPLORING PHARMACY STUDENTS' CHALLENGES IN DECODING ENGLISH SCIENTIFIC LITERATURE

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ABSTRACT

The ability to comprehend English scientific literature is an essential competency for pharmacy students, as evidence-based pharmaceutical practice relies heavily on accessing and interpreting international research. However, many English as a Foreign Language (EFL) learners continue to experience considerable difficulties when engaging with authentic scientific articles. This study aimed to explore the challenges encountered by Indonesian pharmacy students in reading English scientific literature, identify the factors contributing to these difficulties, and examine the strategies they employ to overcome them. A qualitative case study design was adopted. Data were collected through semi-structured interviews with five undergraduate pharmacy students at a private university in Surakarta, Indonesia, and analyzed using Braun and Clarke's thematic analysis. The findings revealed three major themes. First, students experienced multidimensional challenges, including unfamiliar pharmaceutical terminology, complex grammatical structures, dense academic discourse, difficulties interpreting research methodology and statistical information, and limited comprehension of the overall arguments presented in scientific articles. Second, these challenges were shaped by the interaction of linguistic, cognitive, and disciplinary factors, indicating that successful scientific reading requires more than general English proficiency. Third, participants adopted various self-regulated learning strategies, including utilizing digital translation and learning tools, applying repeated reading and note-taking techniques, and seeking support from peers and lecturers to enhance comprehension. The study highlights the need for integrated English for Pharmacy Purposes (EPP) instruction that combines discipline-specific vocabulary development, scientific reading strategies, research literacy, and technology-supported learning. These findings contribute to the growing literature on English for Specific Purposes by providing empirical insights into scientific reading challenges within Indonesian pharmacy education.

Keywords: English for Pharmacy Purposes, English Scientific Literature, Pharmacy Students; Scientific Reading; Self-regulated Learning

OPEN ACCESS
ISSN 2503 3492 (online)

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Lutfi Ardina Kusuma Ratri

Citation:
Ratri, L. A. K. (2026).Lost in Translation? Exploring Pharmacy Students' Challenges in Decoding English Scientific Literature. *IJILS*,4 (2), 207-228.

INTRODUCTION

English has become the dominant language of scientific communication, accounting for the vast majority of scholarly publications indexed in international databases. In health-related disciplines, including pharmacy, the ability to access and comprehend English scientific literature is no longer an additional skill but a fundamental academic competency (Gholar et al., 2023). Pharmacy students are expected to engage with research articles, systematic reviews, clinical guidelines, drug monographs, and evidence-based medical resources throughout their academic journey and future professional careers. The increasing internationalization of pharmaceutical sciences has intensified the need for students to interpret complex scientific texts written in English, as these texts often provide the most recent evidence regarding drug development, pharmacotherapy, pharmaceutical

technology, and patient care (Amante, 2026). Consequently, English reading proficiency plays a pivotal role in enabling pharmacy students to participate in evidence-based practice and lifelong learning (Nurpahmi & Rahman, 2024).

Within the framework of English for Specific Purposes (ESP), reading serves as a primary means through which learners access discipline-specific knowledge. However, reading scientific literature differs considerably from reading general English texts. Scientific publications frequently contain specialized terminology, information-dense paragraphs, complex grammatical structures, and discipline-specific rhetorical conventions that require readers to coordinate linguistic knowledge with subject-matter understanding (Buehl, 2023; Śleszyńska, 2025) . Successful comprehension therefore involves more than recognizing individual words or translating sentences. Readers must identify relationships between concepts, interpret the organization of scientific arguments, connect information across sections, and evaluate the significance of research findings (Sukisno et al., 2025). For pharmacy students learning English as a foreign language (EFL), these demands may create additional cognitive burdens because linguistic processing and disciplinary interpretation must occur simultaneously. (Buehl, 2023; Śleszyńska, 2025)(Sukisno et al., 2025)

One major challenge concerns the specialized vocabulary used in pharmaceutical and biomedical literature. Scientific texts frequently incorporate technical terms, abbreviations, Latin-derived nomenclature, and concepts whose meanings depend on particular disciplinary contexts (Ulitkin et al., 2020). When students encounter unfamiliar terminology, they may devote considerable attention to identifying individual word meanings, leaving fewer cognitive resources available for integrating information and constructing an general interpretation. Grammatical complexity can intensify this difficulty. Long sentences, nominalizations, passive constructions, and densely structured paragraphs may obscure relationships between scientific concepts and make it difficult for learners to identify the main claims of a text (Laili & Nashir, 2023). These difficulties suggest that comprehension problems cannot be explained exclusively by limited vocabulary; they may also reflect the interaction between linguistic knowledge, reading processes, and the structural characteristics of scientific discourse.(Ulitkin et al., 2020)(Laili & Nashir, 2023)

A further challenge involves students' familiarity with authentic research publications. Students who primarily encounter textbooks, lecture notes, or simplified instructional materials may have limited experience interpreting the organizational and rhetorical features of empirical research articles. Reading such publications requires readers to distinguish research objectives from methodological procedures, interpret results, understand statistical information, and relate conclusions to the evidence presented. Difficulties with these tasks may reduce students' confidence and willingness to engage with scholarly literature, thereby constraining the development of academic reading competence and research literacy (Bhardwaj et al., 2025). Related research in ESP has also identified specialized vocabulary, unfamiliar content, and insufficient reading strategies as potential sources of difficulty when learners engage with discipline-specific texts (Ula et al., 2025). Nevertheless, the relative importance of these challenges may vary according to learners' linguistic proficiency, disciplinary knowledge, and previous experience with scientific reading.(Bhardwaj et al., 2025)(Ula et al., 2025)

Understanding these challenges is particularly important in pharmacy education because evidence-based pharmaceutical practice depends on the ability to access, interpret, and evaluate scientific evidence. Pharmacists must remain informed about developments in drug efficacy, adverse effects, therapeutic interventions, and healthcare innovations. Limited competence in reading scientific literature may therefore restrict graduates' ability to engage independently with emerging evidence. Furthermore, the growing availability of digital scholarly databases and AI-assisted learning tools creates additional opportunities for accessing and interpreting scientific information, while also raising questions about students' ability to evaluate information critically. These developments reinforce the need to understand how pharmacy students approach scientific texts, where comprehension difficulties arise, and what strategies they employ to address them.

Previous studies have examined several dimensions of English language education in pharmacy and related ESP contexts. Laili and Nashir (2023) investigated the English language needs of pharmacy diploma students and highlighted the importance of discipline-

specific instruction. Nurpahmi and Rahman (2024) conducted a needs analysis that emphasized the communicative and academic demands of pharmaceutical contexts. Research by Silvia et al. (2025) explored AI-supported ESP instruction, reporting improvements in vocabulary retention and contextual language use among pharmacy students. Mettar (2025) likewise highlighted the importance of aligning English instruction with the disciplinary and professional requirements of pharmacy education. More recently, Ersyad et al. (2026) proposed an AI-driven approach to pharmacy ESP curriculum development, identifying academic reading and technical vocabulary as important learning priorities. In a related ESP context, Wibowo et al. (2025) examined the influence of perceived difficulty and specialized vocabulary on students' comprehension of discipline-specific texts.

Taken together, these studies provide a foundation for understanding pharmacy students' English language needs, the development of discipline-specific curricula, and the potential contribution of technology-supported instruction. However, the specific challenges students experience while reading authentic English scientific literature warrant more focused investigation. Research on language needs and instructional interventions does not necessarily explain how students experience and manage comprehension difficulties when encountering actual scientific publications. In particular, further investigation is needed into how technical vocabulary, grammatical complexity, scientific discourse structures, and disciplinary knowledge interact during reading. Understanding students' responses to these difficulties is also important because identifying barriers alone does not explain how learners attempt to overcome them or which strategies they perceive as useful.

To address this gap, the present study investigates pharmacy students' experiences of reading English scientific literature, focusing on the challenges they encounter, the linguistic, cognitive, and disciplinary factors underlying those challenges, and the strategies they use to manage them. Its contribution lies in examining scientific reading as a multidimensional process situated at the intersection of English language proficiency, disciplinary knowledge, and scientific literacy. Rather than treating reading difficulty solely as a language deficiency or a general educational need, the study considers how different sources of difficulty may shape students' engagement with authentic scientific texts. The findings are expected to inform the development of ESP reading instruction that responds more directly to the academic and professional demands of pharmacy education. Accordingly, this study addresses the following research questions:

1. What challenges do pharmacy students encounter when reading English scientific literature?
2. What linguistic, cognitive, and disciplinary factors contribute to pharmacy students' difficulties in comprehending English scientific texts?
3. How do pharmacy students cope with and overcome challenges when decoding English scientific literature?

METHODS

This study employed a qualitative research approach using a case study design. Qualitative research was considered appropriate because the study aimed to gain an in-depth understanding of pharmacy students' experiences, perceptions, and challenges when reading English scientific literature (Pathak et al., 2013). A case study design was selected to facilitate an intensive exploration of a specific phenomenon within its real-life educational context, namely pharmacy students' experiences in decoding English scientific texts (Yin, 2018). This design enabled the researchers to investigate the complexity of linguistic, cognitive, and disciplinary factors that influence students' reading comprehension and interpretation of scientific articles.

The participants consisted of five undergraduate pharmacy students enrolled at a private university in Surakarta, Central Java, Indonesia. The participants were selected through purposive sampling because they met the specific criteria relevant to the research objectives. The inclusion criteria were: (1) currently enrolled in the Pharmacy Study Program, (2) having experience reading English scientific literature as part of their academic coursework, and (3) being willing to participate voluntarily in the study. To

maintain confidentiality and anonymity, participants were assigned pseudonyms (P1–P5) throughout the reporting of findings.

TABLE 1 | Participants' Demography

Participants' Code	Gender	Year
P1	Female	3rd Year
P2	Female	5th Year
P3	Male	3rd Year
P4	Male	3rd Year
P5	Female	5th Year

Data were collected using semi-structured interviews. The semi-structured format allowed the researchers to prepare guiding questions while maintaining flexibility to explore emerging issues and obtain deeper insights into participants' experiences (Adams, 2015). The interview protocol was developed based on previous literature on English for Specific Purposes (ESP), academic reading comprehension, and scientific literacy among health science students. The interview questions focused on several aspects, including students' experiences in reading English scientific articles, perceived linguistic difficulties, challenges related to technical terminology, strategies used to comprehend scientific texts, and perceptions regarding the importance of English scientific literature in pharmacy education.

TABLE 2 | Interview's Guideline

No	Questions	
	Indonesian Version	English Version
1	Bisakah Anda menceritakan pengalaman Anda dalam membaca artikel atau jurnal ilmiah berbahasa Inggris yang berkaitan dengan bidang farmasi?	Can you describe your experience reading English scientific articles or journals related to pharmacy?
2	Kesulitan apa saja yang biasanya Anda hadapi ketika mencoba memahami literatur ilmiah berbahasa Inggris?	What difficulties do you usually encounter when trying to understand English scientific literature?
3	Bagaimana kesulitan tersebut memengaruhi kemampuan Anda dalam memahami dan menggunakan informasi dari literatur ilmiah berbahasa Inggris?	How do these challenges affect your ability to understand and use information from English scientific literature?
4	Strategi apa yang biasanya Anda gunakan untuk mengatasi kesulitan saat membaca artikel ilmiah berbahasa Inggris?	What strategies do you use to overcome difficulties when reading English scientific articles?

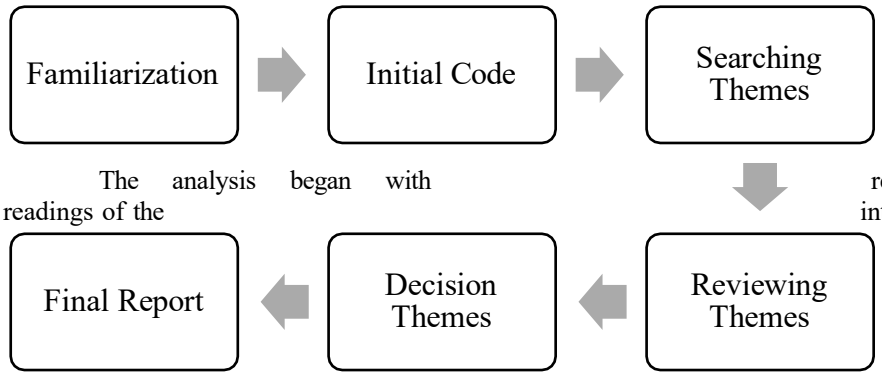
5	Menurut Anda, dukungan atau fasilitas apa yang dibutuhkan mahasiswa farmasi agar lebih mudah memahami literatur ilmiah berbahasa Inggris?	What kind of support or resources do you think would help pharmacy students better understand English scientific literature?

The data collection process was conducted through face-to-face individual interviews. Each interview lasted approximately 30–60 minutes, depending on the depth and richness of participants' responses. Considering that all participants were Indonesian native speakers, the interviews were conducted in Bahasa Indonesia to ensure that participants could express their thoughts, experiences, and challenges accurately and comfortably without being constrained by English language proficiency.

Prior to the interviews, participants were informed about the purpose of the study, their rights as research participants, and the confidentiality of the collected data. Written informed consent was obtained from all participants. With participants' permission, all interviews were audio-recorded to ensure the accuracy and completeness of the data. The recordings were subsequently transcribed verbatim for analysis.

The interview data were analyzed using thematic analysis following the six-phase framework proposed by Clarke and Braun (2006): (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the final report. Thematic analysis was selected because it provides a systematic yet flexible method for identifying, analyzing, and interpreting patterns of meaning within qualitative data.

FIGURE 1 | Data Analysis Process



The analysis began with repeated readings of the interview transcripts to develop familiarity with the data. Initial codes were then generated to capture meaningful segments related to students' experiences and challenges in reading English scientific literature. Similar codes were subsequently grouped into broader categories, which were refined into themes representing recurring patterns across participants' accounts. Throughout the analysis process, the researchers continuously compared codes, categories, and themes to ensure coherence and analytical rigor.

To enhance the trustworthiness of the study, the researchers adopted Lincoln et al. (1985) criteria of credibility, transferability, dependability, and confirmability. Credibility was established through member checking, whereby participants were invited to review and verify the accuracy of the interview transcripts and preliminary interpretations. Transferability was supported by providing detailed descriptions of the research context, participant characteristics, and data collection procedures, enabling readers to assess the applicability of the findings to similar contexts. Dependability was ensured through maintaining a comprehensive audit trail documenting all stages of the research process, including data collection, coding decisions, and theme development. Confirmability was strengthened through researcher reflexivity and peer debriefing, which helped minimize personal bias and ensure that the findings were grounded in participants' perspectives rather than researchers' assumptions. These procedures are widely recommended for establishing quality and rigor in qualitative research.

Ethical principles were observed throughout the study. Participation was entirely

voluntary, and participants were informed of their right to withdraw from the study at any stage without any consequences. All personal information was kept confidential, and pseudonyms were used in reporting the findings. Audio recordings, transcripts, and research documents were securely stored and accessible only to the research team.

RESULTS AND DISCUSSION

Challenges Encountered in Reading English Scientific Literature

The first theme reveals the multifaceted challenges pharmacy students encounter when reading English scientific literature. Although participants acknowledged the importance of international journals for academic learning and professional development, they consistently reported significant difficulties in comprehending scientific texts. These challenges were primarily associated with limited familiarity with specialized terminology, insufficient disciplinary background knowledge, difficulties in understanding complex sentence structures, and challenges in interpreting the overall meaning of research articles.

A prominent issue identified by all participants was the abundance of technical and discipline-specific vocabulary. Unlike general English texts, scientific articles in pharmacy contain highly specialized terminology that is rarely introduced in conventional English language courses. Consequently, students frequently rely on dictionaries, translation tools, or external resources to decode unfamiliar terms, which substantially slows down the reading process and disrupts comprehension.

The integration of differentiated instructional strategies and adaptive learning technologies is of utmost importance in accommodating the varying abilities and learning speeds observed among students. Furthermore, the emphasis on ongoing assessments and feedback mechanisms helps refine and enhance the personalized learning paths. By systematically incorporating learner-cantered methodologies, educators can create an environment that optimizes language acquisition outcomes. This approach not only aligns with contemporary educational paradigms that advocate for inclusivity and fairness, but also ensures that instructional design remains responsive to the evolving needs and aspirations of the learners. Thus, the development of customized pedagogical structures emerges as a cornerstone in the advancement of effective English language education.

As P1 explained that scientific articles contain numerous specialized terms that are unfamiliar to students:

> *"When reading English pharmacy journals, I often encounter terms that I have never learned before. As a result, I frequently need to consult a dictionary, and this makes the reading process very slow." (P1)*

This finding suggests that lexical knowledge remains a fundamental barrier to scientific literacy. Consistent with the concept of academic literacy, vocabulary knowledge serves as a prerequisite for accessing disciplinary knowledge, and limitations in this area may hinder students' ability to engage effectively with scientific texts.

Similarly, participants emphasized that understanding terminology alone was often insufficient because scientific concepts require both linguistic and disciplinary knowledge. P2 highlighted the difficulty of connecting English terminology with pharmaceutical concepts:

> *"My biggest difficulty is understanding highly specific pharmaceutical and medical terms. Sometimes I know the English meaning of a word, but I do not understand the pharmaceutical concept behind it." (P2)*

This statement illustrates the dual challenge faced by pharmacy students. Reading scientific literature is not merely a language-learning activity but also a disciplinary learning process. Students must simultaneously decode linguistic information and construct conceptual understanding based on their subject-specific knowledge. Consequently, a lack of disciplinary familiarity can create additional obstacles even when students possess adequate general English proficiency.

Beyond vocabulary and terminology, participants reported difficulties in

comprehending the broader meaning of scientific articles. Several students indicated that they could translate individual words or sentences but struggled to synthesize information and understand the author's intended message. P3 stated:

> *"I can translate most of the words in an article, but it is still difficult to understand the author's overall message." (P3)*

This finding indicates that comprehension challenges extend beyond word-level understanding to higher-order cognitive processes, such as inference-making, information integration, and critical interpretation. Scientific articles often present complex arguments, evidence-based reasoning, and discipline-specific conventions that require readers to actively construct meaning from multiple sections of the text.

Another challenge emerged from the organizational complexity of research articles. Participants reported that sections such as methodology, results, and statistical analyses were particularly demanding because they contain dense information and technical descriptions. P4 explained:

> *"The methods and results sections often confuse me because there is a lot of information that needs to be understood at the same time." (P4)*

The difficulty experienced in these sections may stem from students' limited exposure to research discourse and scientific reporting conventions. Unlike narrative or expository texts commonly encountered in language classrooms, scientific articles require readers to interpret procedural descriptions, data presentations, and empirical findings. This places additional cognitive demands on learners, particularly those who are still developing academic reading skills.

Furthermore, participants perceived international journals as considerably more challenging than textbooks due to their formal style and sophisticated language use. P5 commented:

> *"I find international journals much more difficult than textbooks because the language is more formal and more complex."* (P5)

The perceived complexity of journal articles reflects the distinctive characteristics of academic discourse, which often involves nominalization, passive constructions, technical vocabulary, and lengthy sentence structures. These linguistic features may increase cognitive load and reduce reading efficiency among non-native English-speaking students.

The findings of the present study demonstrate that pharmacy students encounter substantial challenges when reading English scientific literature, particularly in relation to technical vocabulary, disciplinary knowledge, comprehension of complex academic discourse, and interpretation of research findings. These findings reinforce the notion that reading scientific literature in English involves a multidimensional literacy process that extends beyond general language proficiency and requires the integration of linguistic, cognitive, and disciplinary competencies (Hossain, 2024; Iswara et al., 2026).

One of the most prominent findings concerns students' difficulties with specialized pharmaceutical and biomedical terminology. Participants consistently reported that unfamiliar technical vocabulary disrupted their reading fluency and limited their ability to understand scientific texts. This finding aligns with recent research emphasizing the central role of disciplinary vocabulary in health sciences education. A needs analysis conducted among pharmacy students revealed that many learners struggle because English courses often focus on general language skills while providing insufficient exposure to pharmacy-specific terminology, resulting in a gap between classroom instruction and disciplinary demands. Likewise, research on English scientific vocabulary among health science students demonstrated a significant relationship between mastery of scientific terminology and successful comprehension of English for Specific Purposes (ESP) texts, suggesting that vocabulary knowledge functions as a critical foundation for disciplinary literacy (Arwinda & Rochmawan, 2026; Fakourian & Ghalibafan, 2024).

The current findings further reveal that students frequently recognize the literal meaning of English words but struggle to understand the underlying pharmaceutical concepts represented by those terms. This observation supports contemporary perspectives

on disciplinary literacy, which argue that vocabulary acquisition alone is insufficient unless accompanied by conceptual understanding and professional knowledge construction. Recent studies in health sciences education similarly report that students often face difficulties interpreting specialized terminology because comprehension requires both linguistic knowledge and familiarity with domain-specific concepts. Therefore, the challenge experienced by participants is not solely linguistic but also epistemological, as students must learn the conceptual frameworks embedded within scientific discourse (Pieterman-Bos et al., 2024).

Another important finding concerns students' difficulties in understanding the overall meaning of scientific articles despite being able to translate individual words and sentences. Participants reported challenges in identifying the authors' intentions, synthesizing information across sections, and constructing coherent interpretations of research findings. This finding is consistent with previous studies showing that academic reading difficulties often emerge at higher levels of comprehension rather than at the lexical level alone. Research investigating students' engagement with academic journals found that learners frequently struggle to identify central arguments and integrate information across texts because scientific literature requires advanced inferential and analytical reading skills (Gebremariam & Weldeyohannes, 2025; Nadalini et al., 2025). These findings suggest that comprehension of scientific literature involves complex cognitive processes, including inference generation, critical evaluation, and knowledge integration.

The present study also highlights the influence of complex grammatical structures and formal academic writing conventions on reading comprehension. Participants described difficulties processing lengthy sentences, passive constructions, and information-dense paragraphs commonly found in research articles. Similar findings have been reported in recent investigations of health sciences students, where academic language complexity was identified as a significant barrier to comprehension and academic performance. Scientific writing often relies on nominalization, embedded clauses, and discipline-specific rhetorical structures that increase cognitive load and require readers to allocate substantial mental resources to sentence processing before meaning can be constructed (Deroncele-Acosta et al., 2024). Consequently, linguistic complexity may hinder students' ability to efficiently access scientific knowledge, particularly among learners who use English as a foreign language.

A further challenge identified in this study relates to students' limited familiarity with research discourse and scientific reporting conventions. Participants reported particular difficulties in understanding methodology, statistical analyses, and research findings. This finding extends previous literature by demonstrating that reading difficulties are not confined to language-related factors but are also associated with insufficient research literacy. Recent studies on health literacy among medical and health science students emphasize that successful engagement with scientific information requires the ability to interpret research evidence, evaluate methodological procedures, and understand data presentation. Students who lack these competencies may find it difficult to comprehend scientific arguments even when the language itself is understandable (Morris, 2025).

The findings additionally support emerging evidence suggesting that health sciences students often possess varying levels of scientific and health literacy despite studying within specialized disciplines. Research conducted among university students in health-related fields found that differences in literacy levels significantly affect learners' capacity to access, interpret, and apply scientific information. In the context of the present study, students' struggles with research articles appear to reflect broader challenges in scientific literacy, particularly regarding the interpretation of evidence-based information and the understanding of scientific communication practices (Bossér, 2024; Nugroho & Dewi, 2025).

From a theoretical perspective, these findings can be interpreted through the lens of Academic Literacy Theory and Disciplinary Literacy Theory (Li, 2022; Shanahan & Shanahan, 2012). Academic literacy emphasizes that successful participation in higher education requires mastery of discipline-specific language practices, while disciplinary literacy highlights the importance of understanding how knowledge is constructed and communicated within particular fields. The experiences reported by participants

demonstrate that reading English scientific literature requires students to navigate both linguistic conventions and disciplinary ways of thinking. Consequently, reading difficulties emerge when students lack adequate preparation in either domain.

An important contribution of the present study lies in its examination of pharmacy students within the Indonesian higher education context. While previous studies have generally investigated health sciences students' English proficiency or health literacy, relatively few studies have qualitatively explored how pharmacy students experience and interpret the challenges of reading English scientific literature (Laili & Nashir, 2023; Nurpahmi & Rahman, 2024). The findings therefore provide a more nuanced understanding of the interconnected linguistic, cognitive, and disciplinary barriers that influence students' engagement with international research publications.

Factors Contributing to Difficulties in Comprehending English Scientific Texts

The second theme explores the underlying factors that contribute to pharmacy students' difficulties in comprehending English scientific literature. Analysis of the interview data revealed that students' reading challenges were influenced by a complex interaction of linguistic, cognitive, and disciplinary factors. Participants consistently emphasized that successful comprehension of scientific articles requires more than general English proficiency; it demands familiarity with specialized terminology, mastery of academic discourse conventions, and sufficient understanding of research-related concepts. Three interconnected sub-themes emerged from the data: limited mastery of technical vocabulary, difficulties with complex grammatical structures and academic writing style, and insufficient background knowledge of research methodology.

Limited Mastery of Technical Vocabulary

A dominant factor reported by all participants was their limited knowledge of pharmaceutical and biomedical terminology. Although students generally possessed adequate competence in everyday English, they struggled when encountering discipline-specific vocabulary embedded within scientific articles. The specialized nature of pharmaceutical discourse often created substantial barriers to comprehension, as unfamiliar terms interrupted the reading process and required frequent consultation of dictionaries, translation tools, or external sources. P1 explained:

> *"I can generally understand common English vocabulary, but pharmaceutical terms such as pharmacokinetics or bioavailability often create difficulties for me." (P1)*

Similarly, P5 stated:

> *"Many scientific terms are not taught in depth in English courses, so I have to learn them independently." (P5)*

These findings suggest that lexical challenges extend beyond general language proficiency and are closely linked to disciplinary literacy. Scientific terminology often represents complex concepts that require both linguistic recognition and conceptual understanding. Students may recognize the literal meaning of a term but still struggle to understand its significance within a pharmaceutical context. Consequently, limited technical vocabulary knowledge restricts students' ability to construct meaning from scientific texts and hinders the development of deeper conceptual understanding.

Furthermore, participants' experiences indicate a gap between English language instruction and the linguistic demands of pharmacy education. General English courses may provide foundational language skills; however, they often offer limited exposure to the specialized vocabulary that dominates scientific literature. As a result, students are required to independently develop disciplinary vocabulary knowledge, which may create disparities in reading competence and increase cognitive burden during the reading process.

Complex Grammatical Structures and Academic Writing Style

Another significant factor contributing to comprehension difficulties was the

complexity of grammatical structures and the formal characteristics of academic writing. Participants reported that scientific articles frequently contain lengthy sentences, dense information, and sophisticated syntactic patterns that differ substantially from the texts they typically encounter in English language classrooms. P2 explained:

> *"Sentences in journal articles are often very long and consist of multiple clauses, so I have to read them repeatedly." (P2)*

Likewise, P4 stated:

> *"The use of passive voice and complicated sentence structures makes it difficult for me to identify the main idea of the article." (P4)*

These accounts illustrate the challenges associated with processing academic discourse. Scientific writing is characterized by complex grammatical features, including embedded clauses, nominalization, passive constructions, and dense noun phrases. Such linguistic features enable authors to convey large amounts of information concisely; however, they also increase the cognitive demands placed on readers. For students whose English proficiency is still developing, processing these structures requires substantial cognitive effort, often reducing reading fluency and comprehension efficiency.

Moreover, participants reported difficulties identifying key arguments and distinguishing essential information from supporting details. This suggests that comprehension problems arise not only from unfamiliar vocabulary but also from challenges in navigating the rhetorical and organizational conventions of scientific writing. The need to repeatedly reread passages reflects the cognitive load imposed by dense academic texts and highlights the gap between students' existing reading abilities and the demands of authentic scientific literature.

The findings further indicate that students often approach scientific texts through a word-by-word translation strategy. While this approach may facilitate understanding at the sentence level, it can hinder broader comprehension because it limits students' ability to perceive the overall structure and argumentation of the text. Consequently, grammatical complexity becomes a barrier to both local comprehension and global interpretation.

Limited Background Knowledge of Research Methodology

Beyond linguistic challenges, participants identified limited knowledge of research methodology as a major obstacle to understanding scientific articles. Several students reported difficulties interpreting methodological procedures, statistical analyses, and data presentations, even when the language itself appeared understandable. P3 explained:

> *"I often struggle to understand the statistics section because I am not very familiar with the research methods being used."* (P3)

Similarly, P5 stated:

> *"When reading research findings, I become confused about how to interpret the data and graphs presented in the article."* (P5)

These responses indicate that scientific literacy involves more than language competence. Understanding research articles requires familiarity with the conventions of scientific inquiry, including research design, data analysis, statistical interpretation, and evidence-based reasoning. Students who lack sufficient methodological knowledge may experience difficulties comprehending the significance of findings, evaluating research quality, and connecting results to broader scientific discussions.

Participants' challenges in interpreting statistical information are particularly noteworthy because statistical data serve as the foundation for scientific claims in pharmaceutical research. Without adequate methodological literacy, students may be able to read individual sentences yet remain unable to critically evaluate or meaningfully interpret the research findings. This limitation reduces the educational value of scientific literature and may restrict students' engagement with evidence-based practice, which is essential in pharmacy education.

Furthermore, unfamiliarity with the organizational structure of research articles appears to contribute to comprehension difficulties. Scientific papers follow conventional formats such as Introduction, Methods, Results, and Discussion (IMRaD), each serving a distinct communicative purpose. Students who lack awareness of these conventions may struggle to identify the function of each section and to understand how different components contribute to the overall argument of the study.

The present study reveals that pharmacy students' difficulties in comprehending English scientific literature stem from a complex interaction of linguistic, cognitive, and disciplinary factors. Specifically, limited mastery of technical vocabulary, difficulties in processing complex grammatical structures, and insufficient knowledge of research methodology emerged as the primary contributors to comprehension challenges. These findings reinforce contemporary perspectives on academic and disciplinary literacy, which emphasize that successful engagement with scientific literature requires more than general English proficiency; it necessitates the integration of language competence, content knowledge, and scientific literacy.

One of the most significant factors identified in this study is students' limited mastery of pharmaceutical and biomedical terminology. Participants consistently reported difficulties understanding discipline-specific vocabulary, even when they possessed adequate knowledge of general English. This finding is consistent with recent studies in English for Specific Purposes (ESP) and health sciences education, which have highlighted specialized vocabulary as one of the most critical determinants of successful scientific reading. For example, Gilo and Mohammed (2024) found that mastery of English scientific vocabulary significantly predicts students' ability to comprehend ESP texts among health-related disciplines.

Similarly, Nurpahmi and Rahman (2024) reported that pharmacy students frequently struggle with academic texts because English courses often prioritize general communication skills rather than pharmaceutical terminology. Consequently, students encounter substantial difficulties when transitioning from classroom English to authentic scientific literature.

The current findings further indicate that vocabulary-related difficulties are not merely lexical in nature but also conceptual. Participants often recognized the English meaning of a term but failed to understand its pharmaceutical significance. This observation supports the argument advanced by Yagin and Fernandes (2024), who noted that medical and pharmaceutical terminology represents a form of disciplinary knowledge that requires conceptual understanding in addition to linguistic recognition. In other words, students must simultaneously acquire vocabulary knowledge and develop an understanding of the scientific concepts represented by those terms. This dual challenge reflects the principles of disciplinary literacy, which emphasize that reading within a specific field requires mastery of both language and professional knowledge structures.

Another important finding concerns the role of complex grammatical structures and academic writing conventions in hindering comprehension. Participants reported difficulties interpreting lengthy sentences, passive constructions, embedded clauses, and information-dense paragraphs that are characteristic of scientific discourse. These findings are consistent with recent research demonstrating that academic language complexity remains a major obstacle for students in health sciences programs. Ponnudurai et al. (2025), for instance, found that the readability level of scientific texts often exceeds the linguistic competence of first-year medical students, leading to reduced comprehension and increased cognitive effort. Similarly, Shen et al. (2023) argued that the syntactic complexity of scientific writing creates substantial processing demands for English as a Foreign Language (EFL) learners, particularly when readers are unfamiliar with academic discourse conventions.

The findings also support cognitive theories of reading comprehension, which suggest that excessive linguistic complexity increases cognitive load and reduces readers' capacity to construct meaning from a text. Participants frequently reported rereading passages multiple times in an attempt to understand the main ideas of articles. Such experiences indicate that students allocate considerable cognitive resources to decoding sentence structures, leaving fewer resources available for higher-order comprehension processes such as inference-making, critical evaluation, and synthesis of information. Similar observations were reported by Zhang (2024), who found that EFL students reading

scientific texts often become overwhelmed by complex syntax, resulting in fragmented understanding and reduced reading efficiency.

Furthermore, participants indicated that they frequently relied on word-by-word translation strategies when encountering difficult passages. This finding resonates with studies by Liu and Yang (2025), which demonstrated that health sciences students often depend heavily on translation-based approaches due to limited confidence in academic reading. While such strategies may support local comprehension, they often impede global understanding because students become focused on individual words rather than broader textual meaning. Consequently, translation-oriented reading may limit students' ability to identify relationships among concepts and comprehend scientific arguments holistically.

Beyond linguistic challenges, the present study highlights the importance of methodological literacy in understanding scientific literature. Participants consistently reported difficulties interpreting research designs, statistical analyses, graphs, and empirical findings. These findings extend previous research by demonstrating that comprehension barriers are not solely language-related but also stem from limited familiarity with scientific inquiry and evidence-based reasoning. Baralin et al. (2025), in their systematic review of health literacy among medical students, emphasized that understanding scientific evidence requires competencies in data interpretation, methodological evaluation, and critical appraisal. Students who lack such competencies may struggle to comprehend research articles regardless of their language proficiency.

Similarly, Virtič (2022) found that undergraduate health science students often demonstrate varying levels of scientific literacy, particularly in relation to interpreting statistical evidence and research outcomes. The current findings support this conclusion, as participants frequently expressed confusion when encountering statistical information and research findings. Such difficulties are especially concerning within pharmacy education because evidence-based practice relies heavily on the ability to evaluate scientific studies and apply research findings to professional decision-making.

An additional contribution of the present study relates to students' limited familiarity with the organizational structure of scientific articles. Participants reported difficulties understanding how different sections of research articles contribute to the overall argument of a study. This finding is supported by recent research indicating that novice readers often lack awareness of genre-specific conventions within scientific writing (Deng et al., 2024; Söğüt et al., 2024). Understanding the communicative purposes of the Introduction, Methods, Results, and Discussion (IMRaD) structure is essential for effective navigation of research articles. Without such knowledge, students may struggle to identify key information and interpret the significance of research findings.

The findings can be further interpreted through the framework of Cognitive Academic Language Proficiency (CALP) proposed by Cummins. According to this perspective, academic success requires the development of advanced language skills that extend beyond everyday communication. Scientific literature demands sophisticated vocabulary knowledge, complex syntactic processing, and critical analytical skills. The experiences reported by participants suggest that many students have not yet fully developed these competencies, thereby limiting their ability to engage effectively with scientific texts.

From a practical perspective, the findings indicate that addressing reading difficulties among pharmacy students requires a comprehensive educational approach. Traditional English instruction that focuses primarily on general language skills may be insufficient to prepare students for the demands of scientific reading. Instead, curricula should integrate pharmaceutical terminology, scientific reading strategies, research methodology, and evidence-based literacy into English instruction. Such an approach would align with recent recommendations in ESP and health sciences education, which advocate for closer integration between language learning and disciplinary knowledge development (Huang et al., 2024; Riaz et al., 2026).

Strategies Used to Overcome Challenges in Reading English Scientific Literature

The third theme explores the strategies employed by pharmacy students to overcome the various linguistic, cognitive, and disciplinary challenges encountered while reading English scientific literature. Despite experiencing considerable difficulties in understanding

scientific articles, participants demonstrated active efforts to facilitate comprehension and improve their reading effectiveness. Analysis of the interview data revealed that students adopted a range of compensatory and self-regulated learning strategies, which can be categorized into three interconnected sub-themes: utilizing digital translation and learning tools, applying repeated reading and note-taking strategies, and seeking peer and lecturer support.

The findings suggest that students do not passively experience difficulties; rather, they actively engage in problem-solving behaviors to bridge gaps in their language proficiency and disciplinary knowledge. These strategies reflect learners' attempts to develop academic literacy and gain access to scientific knowledge that is essential for their professional development as future pharmacists.

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Utilizing Digital Translation and Learning Tools

A prominent strategy reported by all participants was the use of digital technologies to facilitate comprehension of scientific texts. Students frequently relied on online translation platforms, electronic dictionaries, medical terminology databases, and internet-based resources to assist them in understanding unfamiliar vocabulary, complex sentences, and specialized pharmaceutical concepts. P1 explained:

> *"I usually use Google Translate or DeepL to help me understand difficult sentences."* (P1)

Similarly, P2 stated:

> *"I often search for terms that I do not understand through the internet or medical dictionary applications."* (P2)

These findings indicate that digital tools function as an important form of linguistic scaffolding, enabling students to access meanings that would otherwise remain incomprehensible. The availability of translation technologies allows learners to overcome immediate lexical barriers and maintain continuity during the reading process. Rather than abandoning difficult texts, students utilize technology as a mediating resource that supports comprehension and promotes independent learning.

However, participants also suggested that translation tools are most effective when used selectively rather than as a substitute for comprehension. Several students explained that they often compare multiple sources of information, including online explanations, videos, and academic websites, to verify meanings and gain a deeper understanding of concepts. This behavior reflects a growing awareness that scientific literacy requires more than direct translation; it involves interpreting terminology within its disciplinary context.

The findings further reveal the increasing role of technology in contemporary academic reading practices. Digital resources not only provide linguistic assistance but also facilitate access to conceptual explanations and background information. Consequently, technology serves as both a language-support tool and a knowledge-building resource that

helps students navigate the complexities of scientific discourse.

Applying Repeated Reading and Note-Taking Strategies

Another important strategy identified by participants was the use of repeated reading and note-taking techniques. Students reported that a single reading was often insufficient for comprehending scientific articles due to the density of information and the complexity of academic language. As a result, they adopted iterative reading practices to gradually construct meaning from the text. P3 explained:

> *"I read an article more than once. The first reading is to understand the general idea, and then I read it again to understand the details."* (P3)

Likewise, P4 stated:

> *"I make small notes about important terms and key points so that they are easier to understand."* (P4)

These findings suggest that students employ metacognitive reading strategies to monitor and regulate their comprehension. Through repeated reading, learners move beyond surface-level decoding and progressively develop a more comprehensive understanding of the article's content. The first reading often functions as an orientation stage, while subsequent readings allow students to focus on specific details, identify relationships among ideas, and clarify misunderstandings.

The use of note-taking further demonstrates students' active engagement with scientific texts. By recording key terminology, summarizing essential information, and highlighting important concepts, students externalize their thinking processes and create personalized learning resources for future review. Such practices can reduce cognitive overload by organizing complex information into more manageable forms.

Moreover, note-taking appears to facilitate vocabulary retention and conceptual understanding. Given the highly specialized nature of pharmaceutical literature, maintaining personal records of unfamiliar terms enables students to gradually build disciplinary knowledge and strengthen long-term comprehension. These strategies illustrate that successful engagement with scientific literature often involves active interaction with the text rather than passive reading.

Seeking Peer and Lecturer Support

In addition to individual learning strategies, participants emphasized the importance of social and academic support in overcoming reading difficulties. Students frequently sought assistance from peers and lecturers when encountering particularly challenging sections of scientific articles. Collaborative learning emerged as an important mechanism for clarifying misunderstandings and expanding comprehension. P5 explained:

> *"If there is a section that is very difficult, I usually discuss it with friends or ask a lecturer."* (P5)

Similarly, P2 reported:

> *"Group discussions are very helpful because friends often have different understandings and can explain things to each other."* (P2)

These responses highlight the social dimension of academic literacy development. Understanding scientific literature is not always an individual process; it often involves interaction with more knowledgeable peers, instructors, and academic communities. Through discussion and collaborative interpretation, students gain access to alternative perspectives that may help clarify difficult concepts, research procedures, or methodological issues.

Participants' reliance on lecturers further underscores the importance of expert guidance in developing scientific reading competence. Lecturers serve not only as sources of content knowledge but also as facilitators who help students understand disciplinary conventions and research practices. Their explanations can bridge the gap between language comprehension and conceptual understanding, particularly when students

encounter unfamiliar scientific concepts.

Furthermore, collaborative learning appears to promote confidence and reduce anxiety associated with reading complex English texts. Students reported feeling more comfortable engaging with challenging articles when they had opportunities to discuss them with others. This suggests that social interaction functions as both a cognitive and affective support mechanism, enhancing comprehension while encouraging sustained engagement with scientific literature.

The present study demonstrates that pharmacy students actively employ a combination of technological, cognitive, metacognitive, and collaborative strategies to overcome difficulties in reading English scientific literature. Rather than remaining passive recipients of information, participants engaged in various forms of self-regulated learning (SRL) by identifying learning resources, monitoring their comprehension, evaluating their understanding, and seeking appropriate academic support. These findings suggest that successful engagement with scientific literature depends not only on students' linguistic competence but also ontheir ability to regulate their own learning processes.

One of the most prominent findings concerns students' extensive use of digital translation and learning tools. Participants consistently reported using applications such as Google Translate, DeepL, online medical dictionaries, and internet-based resources to understand unfamiliar terminology and complex scientific expressions.

This finding is consistent with recent studies demonstrating that digital technologies function as effective scaffolding tools for academic reading. Khalil et al. (2024) found that adaptive digital feedback supports students' metacognitive monitoring and encourages learners to regulate their comprehension while completing academic tasks. Likewise, Wong et al. (2025), in their systematic review of educational chatbots and self-regulated learning, concluded that technology can effectively support learners in identifying learning resources, monitoring understanding, and selecting appropriate learning strategies.

The present findings extend previous studies by illustrating that pharmacy students use digital technologies not merely for direct translation but also for conceptual clarification. Participants explained that they frequently compared information from multiple online sources, including videos, medical websites, and electronic dictionaries, to verify meanings and understand pharmaceutical concepts. This behavior reflects higher levels of self-regulated learning, in which students actively evaluate information rather than accepting machine-generated translations uncritically. Such findings support recent evidence that educational technologies are most beneficial when they encourage reflection, monitoring, and critical evaluation instead of replacing learners' cognitive processes (Muniroh et al., 2024).

Another important finding concerns students' application of repeated reading and note-taking strategies. Participants indicated that they rarely understood scientific articles after a single reading and therefore intentionally reread texts several times while recording important terminology and key ideas. These findings align with contemporary theories of self-regulated learning, which describe rereading and note-taking as metacognitive strategies that facilitate planning, monitoring, and evaluation during reading (Ayasrah & Almulla, 2026; Chen et al., 2025). Recent studies on self-regulated academic reading similarly demonstrate that repeated reading enables learners to gradually construct deeper conceptual understanding while reducing comprehension errors.

The present findings further support recent evidence that repeated reading functions as an essential component of successful academic reading among second-language learners. Research on technology-enhanced self-regulated second language learning concluded that effective readers continually revisit texts, monitor comprehension, and adjust their reading strategies according to task difficulty rather than relying on a single reading (Heriyawati et al., 2024). In the present study, participants followed a similar pattern by first identifying the overall meaning of an article before rereading specific sections to understand detailed methodological procedures and scientific concepts. This finding suggests that repeated reading represents a deliberate metacognitive strategy rather than simply a response to reading difficulty.

Participants also emphasized the importance of note-taking for organizing information and retaining unfamiliar pharmaceutical terminology. Recording key concepts and summarizing important ideas appeared to reduce cognitive overload and facilitate long-

term retention of disciplinary knowledge. These findings support previous research suggesting that externalizing information through written notes enables learners to organize complex knowledge structures more efficiently and enhances deeper cognitive processing during academic reading (Rehman et al., 2023; Taye & Teshome, 2025; Yasuda, 2023).

Beyond individual learning strategies, this study highlights the significant role of peer collaboration and lecturer support in facilitating comprehension of scientific literature. Participants frequently discussed difficult journal articles with classmates and consulted lecturers when they encountered unfamiliar concepts or research methodologies. These findings reinforce sociocultural perspectives on learning, which emphasize that knowledge construction occurs through interaction with more knowledgeable individuals. Similar conclusions have been reported in recent studies demonstrating that collaborative learning environments promote both cognitive development and self-regulated learning by encouraging explanation, reflection, and shared problem-solving (Hamzat, 2024; Paethrangsi et al., 2024).

Interestingly, the current findings suggest that peer discussion provides benefits extending beyond conceptual clarification. Participants reported that collaborative learning reduced anxiety when reading complex English scientific texts and increased their confidence in interpreting research findings. This observation is consistent with recent reviews indicating that technology-supported and collaborative learning environments can simultaneously strengthen cognitive engagement and learners' motivational regulation, both of which are fundamental components of self-regulated learning.

Another notable contribution of the present study is the identification of the complementary relationship between technology-assisted learning and human academic support. Whereas previous studies have frequently examined digital learning tools or collaborative learning separately, the findings indicate that pharmacy students naturally combine these resources during authentic academic reading. Students first rely on digital technologies to resolve immediate linguistic difficulties before seeking clarification through peer discussion or lecturer guidance when conceptual understanding remains incomplete. This sequential use of technological and social support illustrates a sophisticated pattern of self-regulated learning in which learners strategically select different resources according to the nature of the difficulty encountered (Hidayati et al., 2024; Mustofa & Romadhon, 2024).

From a theoretical perspective, these findings can be interpreted through Zimmerman's self-regulated learning framework, which conceptualizes learning as a cyclical process involving planning, performance monitoring, and self-reflection (Zimmerman, 1995). Participants demonstrated each of these phases by selecting appropriate digital resources before reading, monitoring comprehension through repeated reading and note-taking, and evaluating their understanding through discussions with peers and lecturers. The findings therefore provide empirical evidence that reading English scientific literature is not solely a language-learning activity but also a self-regulated learning process requiring continuous cognitive, metacognitive, and motivational regulation. This interpretation is supported by recent systematic reviews emphasizing that technology-enhanced learning environments are most effective when they promote learners' active regulation of cognition rather than passive information consumption (Huda et al., 2025; Socratous et al., 2025).

The present study contributes to the growing body of literature by demonstrating how Indonesian pharmacy students integrate multiple learning strategies to overcome challenges associated with English scientific literature. While previous research has largely examined self-regulated learning or technology-assisted reading in general higher education contexts, the current findings provide context-specific evidence from pharmacy education, where reading authentic international journals constitutes an essential component of professional preparation. The study therefore extends existing literature by illustrating how technological, metacognitive, and collaborative strategies operate simultaneously within the context of English for Pharmacy Purposes (Laili & Nashir, 2023; Silvia et al., 2025).

CONCLUSION

This study explored the challenges encountered by Indonesian pharmacy students when reading English scientific literature, the factors contributing to these difficulties, and the strategies they employ to overcome them. The findings revealed that students experience multidimensional challenges, including unfamiliar pharmaceutical terminology, complex grammatical structures, dense academic discourse, difficulties interpreting research methodology and statistical information, and limited understanding of the overall arguments presented in scientific articles. These challenges are shaped by the interaction of linguistic, cognitive, and disciplinary factors, indicating that successful comprehension of scientific literature requires more than general English proficiency. To address these difficulties, students actively adopted various self-regulated learning strategies, including utilizing digital translation and learning tools, applying repeated reading and note-taking techniques, and seeking support from peers and lecturers. Collectively, these findings demonstrate that reading English scientific literature is a complex process requiring the integration of language competence, disciplinary knowledge, scientific literacy, and self-regulated learning skills. Furthermore, the study contributes to the growing literature on English for Pharmacy Purposes (EPP) by providing a comprehensive understanding of the challenges faced by Indonesian pharmacy students and highlighting the need for more integrated ESP instruction that incorporates discipline-specific vocabulary, scientific reading strategies, and research literacy.

Future research is recommended to involve larger and more diverse samples across multiple universities to enhance the transferability of the findings and provide broader insights into pharmacy students' experiences. Longitudinal and mixed-methods studies are also needed to investigate the development of scientific reading competence over time and to evaluate the effectiveness of instructional interventions, such as English for Pharmacy Purposes courses, scientific reading strategy instruction, AI-assisted learning technologies, and research literacy training. Additionally, comparative studies involving students from other health science disciplines, such as medicine, nursing, and dentistry, would provide a deeper understanding of discipline-specific and shared challenges in comprehending English scientific literature, thereby informing the design of more effective ESP curricula and evidence-based educational practices.

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