

Unpacking Technical Vocabulary Barriers in IoT Assembly: A Qualitative Needs Analysis of Vocational Students

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ABSTRACT

The rapid integration of digital technologies in vocational education demands highly specialized linguistic competencies, particularly for engineering students navigating complex instructional manuals and software interfaces. This qualitative study explores the specific English language barriers encountered by vocational learners and investigates their target needs for instructional media development. Framed within the English for Specific Purposes paradigm, the research involved 31 students in the 11th grade of the Industrial Electronics Engineering program at SMK Negeri 3 Selong, Indonesia. Data were gathered through open ended needs analysis questionnaires and subsequently processed using an interactive qualitative analysis model encompassing data condensation, data display, and conclusion drawing. The findings reveal a multifaceted language barrier where students simultaneously struggle with digital software interfaces, printed instructional manuals, and the physical identification of hardware components. Furthermore, the analysis indicates a strong student demand for a highly contextualized, multimodal learning approach. The participants explicitly requested instructional videos that synchronize authentic visual demonstrations of Internet of Things module assembly with clear bilingual text overlays to mitigate cognitive overload. This study concludes that general English instruction is fundamentally inadequate for vocational contexts, emphasizing the urgent necessity for tailored multimedia interventions to enhance technical vocabulary mastery.

Keywords: English for Specific Purposes, Technical Vocabulary, Vocational Education, Needs Analysis, Qualitative Research

ABSTRAK

Integrasi teknologi digital yang cepat dalam pendidikan vokasi menuntut kompetensi linguistik yang sangat spesifik, terutama bagi siswa teknik yang harus memahami buku panduan instruksional dan antarmuka perangkat lunak yang kompleks. Studi kualitatif ini mengeksplorasi hambatan bahasa Inggris spesifik yang dihadapi oleh peserta didik vokasi dan menyelidiki target kebutuhan mereka untuk pengembangan media pembelajaran. Menggunakan kerangka paradigma English for Specific Purposes, penelitian ini melibatkan 31 siswa kelas XI jurusan Teknik Elektronika Industri di SMK Negeri 3 Selong, Indonesia. Data dikumpulkan melalui kuesioner analisis kebutuhan terbuka dan selanjutnya diproses menggunakan

model analisis kualitatif interaktif yang mencakup kondensasi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian mengungkapkan adanya hambatan bahasa yang multidimensi di mana siswa secara bersamaan berjuang dengan antarmuka perangkat lunak digital, buku panduan cetak, dan identifikasi fisik komponen perangkat keras. Lebih lanjut, analisis ini menunjukkan adanya permintaan siswa yang kuat terhadap pendekatan pembelajaran multimodal yang sangat kontekstual. Para partisipan secara eksplisit meminta video pembelajaran yang mensinkronkan demonstrasi visual otentik dari perakitan modul Internet of Things dengan teks terjemahan dwibahasa yang jelas untuk mengurangi beban kognitif yang berlebihan. Studi ini menyimpulkan bahwa pengajaran bahasa Inggris umum pada dasarnya tidak memadai untuk konteks kejuruan, sehingga menekankan kebutuhan mendesak akan intervensi multimedia yang disesuaikan guna meningkatkan penguasaan kosakata teknis.

Kata Kunci: *English for Specific Purposes*, Kosakata Teknis, Pendidikan Vokasi, Analisis Kebutuhan, Penelitian Kualitatif

A. Introduction

The transition into the 4th Industrial Revolution has fundamentally transformed global communication networks and industrial manufacturing standards (George, 2024; Luo & Zahra, 2023). Within this interconnected landscape, English functions as the primary catalyst for technological breakthroughs and international trade (Marliana, 2024). For vocational high school students, acquiring advanced English proficiency is no longer a mere academic formality but a mandatory prerequisite for securing competitive positions in the global job market (Datu & Sulindra, 2025; Şahan & Sahan, 2023). To meet these specific professional trajectories, language

instruction must be intricately tailored through the English for Specific Purposes paradigm (Akopova, 2023; Chaovanapricha & Champakaew, 2024). Suhartina (2025) posits through the Ecological Model of English for Specific Purposes that specialized language acquisition cannot occur in isolation; it is deeply embedded within the social behaviors and disciplinary knowledge specific to a given workplace. Terzi (2020) further emphasize that designing effective pedagogical courses requires a rigorous understanding of the target working environment.

Despite these clear industry demands, an observable discrepancy exists between vocational curriculum expectations and the actual language

competencies of the students (Gordon et al., 2021). In Indonesia, the educational framework has theoretically shifted to address these vocational requirements (Yulianti & Fitriansyah, 2024). However, empirical observations at SMK Negeri 3 Selong indicate that students in the Industrial Electronics Engineering department still face severe linguistic limitations. While these learners are tasked with mastering advanced Internet of Things module configurations, their lack of foundational technical vocabulary frequently prevents them from comprehending essential English language software, such as the Arduino IDE, and physical component datasheets. For electronics students, mastering technical vocabulary serves as the standardized lexicon required to describe complex systems and execute practical procedures (Fraser, Higa, & Davies, 2025; Lamah, Dubray, & Jankovic, 2024; Prokopyuk, Solovyeva, Alipichev, & Sergeeva, 2024). Prior research highlights that a deficit in this specific area invariably leads to passive learning behaviors and high academic anxiety (Nguyen, 2025).

Addressing these complex vocabulary barriers requires sophisticated instructional tools (Y. Zeng, Kuo, Chen, Lin, & Shen, 2025). The Cognitive Theory of Multimedia Learning suggests that utilizing synchronized visual and verbal inputs significantly enhances information retention (Mayer, 2024). In vocational settings, students often struggle to connect abstract foreign terms with concrete physical objects (Rahmanu & Molnár, 2024). Integrating multimodal approaches, such as video tutorials that combine physical demonstrations with targeted linguistic scaffolding, has been shown to reduce intrinsic cognitive load and foster deeper conceptual comprehension (Bai, Yang, & Tang, 2022; Wang & Xu, 2024; J. Zeng, Zhang, Zhou, Shang, & Black, 2025). Furthermore, (van Nooijen et al., 2024) argue that visual scaffolding is paramount when introducing highly technical lexicons to novice learners. To construct an effective multimodal pedagogical intervention, educators must first comprehensively understand the precise nature of these linguistic constraints from the learners perspectives. Therefore, this study aims to conduct a rigorous qualitative

needs analysis to unpack the specific language barriers experienced by electronics engineering students and determine their authentic preferences for future instructional media development. To construct an effective multimodal pedagogical intervention, educators must first comprehensively understand the precise nature of these linguistic constraints from the learners' perspective. Therefore, this study aims to conduct a rigorous qualitative needs analysis to unpack the specific language barriers experienced by electronics engineering students and determine their authentic preferences for future instructional media development.

B. Methodology

This research represents the foundational Analysis phase within a broader Research and Development framework utilizing the ADDIE instructional design model (Crompton et al., 2024). The study employed a qualitative descriptive approach to investigate the target needs and learning lacks of the participants within a digital literacy context (Pratolo & Solikhati, 2021). The research setting was SMK Negeri 3 Selong, located in

East Lombok, West Nusa Tenggara. A total population sampling technique was applied, involving 31 students in the 11th grade enrolled in the Industrial Electronics Engineering program. Data were collected using an open ended needs analysis questionnaire designed to capture the students' authentic narratives regarding their daily workshop struggles and media preferences. To systematically evaluate the raw textual data, the researcher utilized the interactive qualitative analysis model developed by Miles, Huberman, and Saldaña (2014).

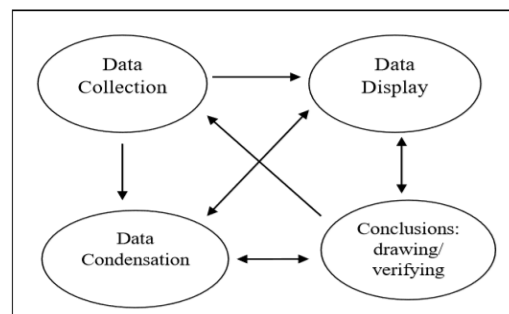


Figure 1. Interactive Model Data Analysis (Miles, Huberman and Saldana, 2014)

As visually represented in Figure 1, this analytical framework does not operate in a strict linear progression. Instead, it functions as a continuous, iterative cycle where the researcher constantly navigates between collecting data, condensing

information, and displaying results to verify emerging pedagogical themes. Utilizing this framework, the rigorous procedure involved 3 concurrent streams of activity. First, data condensation was performed to select and abstract the core themes from the students' Indonesian responses. Second, the condensed data were organized into structured matrices through open and axial coding to observe underlying pedagogical patterns. Finally, conclusion drawing and verification were executed to translate these patterns into definitive instructional design specifications.

C. Findings and Discussion

The qualitative data condensation revealed that the vocational students face highly complex and overlapping barriers during their practical engineering sessions. The abstraction of the students' responses demonstrated that the technical vocabulary deficit spans 3 distinct domains within the laboratory environment: software constraints, literature constraints, and hardware constraints. Students expressed profound difficulty in navigating digital interfaces, decoding procedural steps in printed manuals,

and identifying physical components labeled in English. Crucially, the coding process revealed a mixed constraints category, indicating that a large portion of the cohort reported experiencing all 3 barriers simultaneously. The specific distribution of these difficulties and the authentic narratives from the participants are systematically presented in Table 1.

Table 1 Distribution and Coding of Students' English Language Difficulties

Main Theme	Open Codes (Specific Categories)	Selected Raw Data Quotes and Participant Codes
Software Constraints	Computer/laptop applications, Program interfaces	"Aplikasi pada komputer atau laptop" (P2); "Aplikasi komputer berbahasa inggris" (P13, P29); "aplikasi program berbahasa inggris" (P16).
Literature and Document Constraints	Manual books, Practical modules	"modul berbahasa inggris" (P9); "panduan bahasa inggris" (P14); "buku panduan berbahasa inggris" (P15, P18, P19).
Hardware Constraints	Tool labels and descriptions, Component identification	"Alat alat berbahasa inggris" (P1);

		<i>"keterangan alat alat berbahasa inggris"</i> (P3); <i>"komponen dan alat yang berbahasa inggris"</i> (P7).	capacity to engage in meaningful vocational practice is severely restricted.
Mixed Constraints (Complex Barriers)	Combination of software, hardware, and literature	<i>"aplikasi di komputer dan juga panduan praktik berbahasa inggris"</i> (P5); <i>"buku panduan, keterangan alat dan aplikasi komputer berbahasa inggris"</i> (P12).	When queried about their desired instructional solutions to overcome these identified challenges, the students exhibited a strong intuitive demand for multimodal learning environments. The participants persistently requested explicit textual scaffolding in the form of bilingual subtitles, vocational context through authentic practice demonstrations, and an engaging delivery style utilizing animations to combat learning anxiety. To systematically resolve these interconnected barriers, the qualitative data unequivocally points to the necessity of developing highly specialized instructional media. The direct relationship between the students difficulties and the required pedagogical solutions is explicitly mapped in the axial coding matrix presented in Table 2.

The empirical findings detailed in the matrix highlight a critical paradox within the vocational classroom. The students are tasked with advanced technological procedures, yet they are hindered by a compounding cognitive barrier involving software, hardware, and literary constraints. This tripartite difficulty strongly corroborates the assertions made by Ait El Mouden & Maliki (2024), proving that a generalized English curriculum is entirely insufficient for engineering disciplines. When students struggle simultaneously with digital applications, printed guidebooks, and physical tool descriptions, their

Table 2 Distribution and Coding of Students' English Language Difficulties

Axis of Difficulty (Cause)	Axis of Required Solution (Effect)	Axial Relationship (Synthesis)
Inability to comprehend technical manuals	Requirement for bilingual	Because students struggle significantly with

and software menus.	text support.	reading English instructions, the video must incorporate dual language subtitles to serve as a continuous linguistic bridge.
Confusion regarding abstract terms and physical hardware.	Requirement for authentic visual demonstrations.	The abstract English terminology needs to be visually anchored to actual electronic components and physical assembly actions to help students memorize the vocabulary effectively.
High cognitive load and anxiety when studying technical English.	Requirement for an engaging and relaxed delivery format.	To minimize learning anxiety, the instructional media should integrate creative elements like music and simple animations to make the complex technical material feel more approachable.

The students explicit demands for bilingual subtitles combined with authentic visual demonstrations of Internet of Things module assembly align seamlessly with the Cognitive Theory of Multimedia Learning (Mayer, 2024). By anchoring abstract English terminology to concrete physical actions on the screen,

educators can effectively bridge the gap between digital vocabulary retention and physical workshop application (Kohnke, 2023). Furthermore, providing dual channel multimedia effectively optimizes working memory resources during complex procedural tasks (Hamzah, Hanid, & Zakaria, 2025).

Additionally, the request for engaging and relaxed delivery styles underscores the presence of a high affective filter in specialized language classrooms. Technical material combined with a foreign language naturally induces academic anxiety (Huang & Liu, 2025). Integrating creative elements and clear scaffolding is not merely an aesthetic choice but a necessary psychological intervention to foster motivation, lower the affective filter, and ensure successful language acquisition (Alam, 2026).

Despite the comprehensive insights gained from this qualitative investigation, it is essential to acknowledge specific methodological limitations present within the study. Primarily, the research was conducted within a single vocational institution involving a relatively small and localized cohort of 31 participants.

This specific demographic scope may limit the broad generalizability of the findings to other educational contexts or distinct engineering disciplines. Furthermore, the qualitative data predominantly relies on self reported narratives acquired through open ended questionnaires, which can occasionally be subject to perceptual bias. Future studies should consider expanding the demographic parameters and incorporating direct classroom observational data to further validate these emergent pedagogical themes.

D. Conclusion

This qualitative needs analysis successfully unpacked the specific vocational language barriers faced by Industrial Electronics Engineering students. The findings confirm that these learners encounter intertwined difficulties across 3 main domains: digital software interfaces, technical reading materials, and physical hardware identification. Consequently, relying on conventional, single mode English instruction is pedagogically inadequate. To effectively enhance technical vocabulary mastery, instructional designers and educators

must construct highly contextualized, multimodal video tutorials. These media interventions must synthesize direct linguistic scaffolding through bilingual text with authentic procedural demonstrations, delivered in an engaging manner to mitigate learning anxiety and meet the rigorous demands of the modern industrial workforce.

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