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Technology-Enhanced English Learning (TEEL) for Dental Technician Students: Bridging Language and Technical Skills

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Abstract

Technology-enhanced English Learning (TEEL) has been widely explored in general English instruction but remains underexamined in vocational education, particularly dental technology. Dental technology students must master specialized terminology, communicate effectively with healthcare professionals, and engage with industry-specific tools—many of which operate in English—creating a growing need for targeted language instruction. This study investigates how TEEL supports English for Specific Purposes (ESP) and Teaching English for Specific Purposes (TESP) in addressing dental technicians' specific linguistic and professional requirements. Data were collected from fifteen dental technology students enrolled in TEEL lessons at a private university in Indonesia through semi-structured interviews and classroom observations to explore this. The classroom observations focused on students participating in an English course incorporating TEEL, documenting their interactions with digital tools, engaging in lessons, and applying language skills in professional practice scenarios. Thematic analysis revealed two key findings: (1) the benefits of TEEL for dental technology students, including improved access to resources, self-paced learning, and increased motivation and engagement, and (2) challenges in integrating technology, such as limited access to digital tools and difficulties in adapting them for vocational learning. The results indicate that TEEL positively influences students' acquisition of technical English, enhances their self-efficacy in professional communication, and facilitates real-world learning through interactive simulations. However, disparities in digital literacy and unequal access to technology hinder effective implementation. This study highlights the need for targeted interventions to improve digital literacy and ensure equitable access to technology, thereby maximizing TEEL's impact on vocational education.

Keywords: TEEL, ESP, vocational education, dental technician.

INTRODUCTION

English for Specific Purposes (ESP) within vocational education holds particular significance in regions where English is taught and used primarily as a foreign language (EFL), such as Indonesia. In these settings, the emphasis on general language skills often does

not align with the specialized linguistic demands that vocational students encounter in their technical coursework (Mahbub, 2019; Mahendra, 2020; Natsir et al., 2022; Dewanto et al., 2024). Indonesian students in vocational schools typically receive limited daily exposure to English and rely heavily on local language instruction, making it more challenging to develop targeted, industry-specific English competencies (Jon et al., 2021; Triastuti et al., 2023). For dental technician students in particular, the need for English proficiency becomes especially pressing, given that they must navigate specialized topics such as prosthodontics, orthodontic appliances, and advanced digital fabrication—all of which involve complex terms and concepts predominantly documented in English (Hashmi et al., 2019; Shaalan, 2020; Dudina, 2024). This confluence of language and technical content illustrates why English for Specific Purposes (ESP) is critical: rather than focusing solely on general grammar and conversation, ESP targets the actual reading, writing, and communication skills that students must master to excel in both their coursework and future professional roles (Salmani-Nodoushan, 2020; Menggo, 2022).

Dental technicians design, construct, and repair dental appliances—such as crowns, dentures, bridges, and orthodontic devices—based on dentists' prescriptions and specifications (Eakle & Bastin, 2019). Their work demands precision, a deep understanding of oral anatomy, and the ability to handle specialized materials and equipment, often requiring artistic finesse and scientific knowledge (Takeuchi et al., 2022). As the field of dental technology rapidly evolves, technicians must remain current with new techniques, materials, and digital fabrication processes, including advancements in CAD/CAM systems, 3D printing, and high-strength ceramics (Jurado et al., 2021; Son & Lee, 2021). English proficiency is significant for dental technicians for several reasons. Much of dentistry's cutting-edge research, technical manuals, and industry standards are published in English, while international collaboration frequently relies on English as a lingua franca (Ismail & Al-Moghrabi, 2023; Vahed, 2021). By mastering the specialized English vocabulary used in dentistry, technicians can more accurately interpret prescriptions, reduce the risk of errors, and enhance overall work quality—ultimately contributing to better oral health outcomes for patients (Rodis et al., 2014; Seki et al., 2016; Moross et al., 2017). However, integrating this specialized language learning into a rigorous curriculum presents practical and pedagogical challenges. Dental technician training typically revolves around hands-on tasks, meticulous precision, and consistent engagement with technical upgrades in machinery and materials, leaving limited room for intensive language-focused instruction.

In response to these constraints, Technology-Enhanced English Learning (TEEL) emerges as a strategic approach that leverages digital tools and platforms to create interactive and flexible learning environments beyond the traditional classroom. Mulyadi et al. (2023) and Chau and Lee (2014) note that TEEL capitalizes on resources such as online modules, virtual simulations, multimedia content, and mobile applications to offer authentic, engaging, and context-specific language practice. Sanz (2013) highlights one of TEEL's key advantages—its capacity to mirror real-world professional scenarios. For dental technician students, virtual simulations might replicate laboratory processes, allowing them to practice specialized vocabulary within authentic, problem-solving contexts (Parmaxi, 2020; Moussa et al., 2021). Through virtual reality (VR) or augmented reality (AR), students can rehearse assembling dental prosthetics, navigating 3D models, and troubleshooting equipment while receiving English-language prompts and instructions (Hsu, 2016; Kamińska et al., 2019;

Hilty et al., 2020; Li & Wong, 2021). Additionally, TEEL leverages data-driven insights to personalize learning and track progress, enabling students and instructors to pinpoint areas needing extra attention. This personalized approach ensures that learners receive immediate, targeted support exactly where they need it, making the language acquisition process more efficient and purposeful (Hill & Miller, 2013; Chen, 2022).

Recent research underscores the value of customized, technology-enhanced approaches in teaching English for Specific Purposes (ESP), particularly for EFL learners with specialized needs. In a study involving 26 second-year dental students, Dudina (2024) introduced a specialized English for Specific Purposes (ESP) curriculum and reported significant improvements in general language proficiency and field-specific vocabulary. Similarly, Hashmi et al. (2019) conducted a qualitative investigation with 12 Saudi Arabian dental students, revealing a strong need for updated, interactive, and context-based ESP materials. In Japan, Moross et al. (2017) emphasized the limited focus on English development within undergraduate dental programs, thereby underscoring the importance of comprehensive ESP instruction for future dental professionals. Echoing this perspective, Seki et al. (2016) found that 19 trainee dentistry residents welcomed technology-driven simulation activities for practicing specialized dental English, further illustrating the demand for innovative and targeted language-learning approaches in the field.

Despite the recognized benefits of Technology-Enhanced English Learning (TEEL) in various fields, its implementation within dental education—particularly among Indonesian dental technician students—remains noticeably limited. This gap underscores the need for specialized strategies and tools that tailor TEEL to the unique demands of dental technology, thereby better preparing future technicians for professional practice. The present research proposes a solution by establishing methods and resources specifically designed for dental technology students, ensuring they receive context-relevant language instruction suited to their vocational needs. To achieve this aim, the study first explores theoretical perspectives on how TEEL might benefit or challenge learners in dental technology programs. It examines how online platforms can facilitate engagement, promote self-paced learning, and strengthen professional communication skills, even as it acknowledges potential barriers such as uneven digital access or limited technological literacy. The research offers a novel, evidence-based framework for integrating TEEL into dental technician education in Indonesia and beyond by addressing these considerations.

METHOD

This study's qualitative research design follows guidelines outlined by Creswell (2013), who emphasizes the importance of aligning the chosen approach with the research questions and context. Merriam and Tisdell (2016) assert that qualitative inquiries uncover in-depth perspectives within bounded settings, further informing the decision to use a phenomenological lens. To achieve a rich and nuanced dataset, we utilized purposive sampling, as Patton (2015) recommended, ensuring that participants met specific inclusion criteria relevant to Technology-Enhanced English Learning (TEEL). This approach echoes the rationale of Etikan et al. (2016), who highlight how purposive sampling supports selecting individuals most capable of illuminating the central phenomenon under study. Data analysis adhered to the systematic coding and categorization procedures advocated by Miles

et al. (2014), enabling the identification of recurring themes and patterns in participants' experiences and reflections.

Data collection drew on two core qualitative methods—semi-structured interviews and classroom observations—to investigate how dental technician students engage with Technology-Enhanced English Learning (TEEL). Following Brinkmann's (2018) guidelines, semi-structured interviews were conducted with all 15 participants, using a flexible interview guide to encourage in-depth reflections on their academic comprehension of TEEL, their attitudes toward technology-enhanced language instruction, and any challenges they encountered. Each session, lasting approximately 30 to 45 minutes, was piloted with a small cohort outside the main study to evaluate the clarity, relevance, and alignment of the interview questions (Flick, 2018). This pilot phase was essential for refining the instrument before completing data collection.

To supplement and corroborate interview findings, the study employed deep-focus participant observation, as described by Merriam and Tisdell (2016). Over four weeks, researchers gathered 12 hours of observation data detailing student engagement, participation in TEEL-related tasks, and the frequency of English use during technical discussions. A behavior checklist was also introduced, enabling students to self-monitor attendance and use digital resources. Field notes capturing contextual details were compiled during these observation sessions and integrated with the interview transcripts to enable triangulation (Patton, 2015). Through this multi-faceted approach, the study developed a robust, context-rich account of how TEEL influences students' language learning processes in an applied dental technology setting.

The data were analyzed using the six-phase thematic analysis framework proposed by Braun and Clarke (2006), which involves familiarizing the data, initial coding, searching for themes, reviewing themes, defining and naming themes, and producing the report. Drawing on guidelines from Guest et al. (2012), the research team systematically reviewed transcribed interviews and observation notes, seeking patterns tied to the students' and teachers' experiences with Technology-Enhanced English Learning (TEEL). A second researcher independently coded a subset of the data to ensure inter-coder reliability and compared the results with the first researcher's coding (O'Connor & Joffe, 2020). Any discrepancies were addressed through discussion until a consensus was reached, reinforcing the analytical process's credibility.

The emerging themes were subsequently validated during peer debriefing sessions in line with best practices for enhancing trustworthiness in qualitative research. This step allowed external researchers familiar with qualitative methods to review the thematic structure, offer feedback, and propose refinements (Nowell et al., 2017). A member-checking procedure was implemented to further strengthen the study's rigor, allowing participants to review the preliminary findings and confirm or clarify their perspectives (Tracy, 2010). Throughout the iterative theme generation and revision process, direct quotations were chosen to illustrate key categories and lend authenticity to the findings (Saldaña, 2016). Ultimately, this comprehensive analytical approach produced a robust summary of the benefits and challenges associated with TEEL, forming a solid foundation for understanding the method's overall impact on language instruction in a dental technician context.

FINDING AND DISCUSSION

The thematic analysis generated four tentative themes: engagement through technology, relevance of learning material, professional practice readiness, and challenges in technology integration. These themes were derived by systematically examining initial codes in the interview transcripts and grouping similar or contrasting codes and categories into broader thematic clusters. Once the researcher identified these provisional themes, the transcripts were carefully reviewed again to ensure the data consistently aligned with each theme. Subsequently, each theme was assessed for its significance, relevance to the research focus, and distinctiveness. Finally, these themes were organized in descending order based on the number of coding references.

Table 1. Tentative themes of TEEL for dental technician students

No	Initial Theme	Number of Coding References	Aggregate Coding References
1	Engagement through technology	10	20
2	Relevance of learning material	5	10
3	Professional practice readiness	4	8
4	Challenges in technology integration	4	8

Table 1 provides a concise overview of the four tentative themes that emerged during the thematic analysis: Engagement through technology, Relevance of learning material, Professional practice readiness, and Challenges in technology integration. The "Number of Coding References" column indicates how often specific excerpts from the interview transcripts were labeled with each theme, whereas the "Aggregate Coding References" column reflects a higher total when overlapping or interrelated codes are grouped.

Taken in the context of dental technician education, these themes help illuminate students' experiences with TEEL. Engagement through technology captures how digital tools—such as virtual simulations or online practice modules—foster active learning and motivate students to repeatedly apply and refine their technical and linguistic skills beyond traditional classroom constraints. Relevance of learning material emerges as a key issue, demonstrating that students value TEEL content when it is closely linked to real-world dental scenarios, including specialized vocabulary, lab equipment instructions, and patient communication tasks. Meanwhile, Professional practice readiness underscores students' perceptions of how well they can transfer these English skills into future clinical or laboratory environments, particularly regarding technical fluency and intercultural communication. Finally, Challenges in technology integration address practical barriers such as limited access to necessary software or hardware, inadequate internet connectivity, and varying digital literacy levels among students and instructors.

Engagement through Technology

Many participants reported a learning curve in navigating new digital platforms early in the semester but noted that guidance and practice helped them overcome this hurdle. One

student remarked, "I was frustrated at first because I didn't know how to use all the features. Once I got the hang of it, the lessons became more fun, and I remembered dental terms faster" (Participant 3). Another participant emphasized the peer support aspect, explaining, "My classmates and I share tips on how to use the apps effectively. Working together online made me less nervous about pronouncing difficult words, like those for dental tools and materials" (Participant 8). These comments reflect a broader pattern: once students adjusted to the technology, they found it a valuable aid for mastering specialized English vocabulary related to crowns, dentures, and other essential lab procedures.

Beyond individual adoption, the interviews also revealed that technology fosters community in an otherwise hands-on, technical environment. Eleven participants mentioned that group activities on digital platforms improved their learning motivation. One student highlighted, "We use discussion boards to talk about new techniques in crowns and bridges. Writing about it in English helps me practice the terms I need in the lab" (Participant 2). Observations conducted during four weeks of classes reinforced this finding; for instance, students were seen consulting online glossaries and language apps while assembling prosthetics. This direct connection between digital tools and on-the-job communication was significant in a dental technology context, where precise and accurate descriptions of instruments and procedures are critical for patient safety and professional competence.

Despite these advantages, some participants still struggled with advanced platform features, signaling that ongoing technical support remains necessary. However, the consensus among most of the 15 interviewees was that TEEL invigorates the learning process, particularly in bridging the gap between theoretical language practice and real-world dental technician tasks. Technology integration proved to be both engaging and pragmatic, from employing collaborative apps to simulate lab procedures to using digital dictionaries for clarifying nuanced technical terms. In sum, the theme of Engagement through Technology illustrates that, with the proper guidance, digital tools can enhance students' English language skills and their readiness to perform effectively in a specialized, detail-oriented field like dental technology.

The Relevance of Learning Material

Many participants praised the emphasis on specialized vocabulary and practical exercises tied directly to their training. One student commented, "I now know the English terms for most of the tools I use during my practice sessions. This makes it easier to follow instructions and communicate in class" (Participant 5). Another student added, "The exercises feel realistic, like what we will say or do in the clinic. It makes learning more practical" (Participant 8). Classroom observations corroborated these perceptions, with learners frequently applying newly acquired vocabulary to simulated lab tasks such as constructing dentures or discussing digital 3D printing procedures.

Despite these positive remarks, several students suggested areas for improvement. One student noted, "Some of the vocabulary exercises were useful, but we still needed more practice with real patient interactions. The scenarios should be more advanced" (Participant 10). Another expressed a similar concern: "I can explain basic things well enough, but I'm not confident when discussing more complex topics like implant-supported restorations or new materials" (Participant 12). These insights highlight a desire for more elaborate and clinically oriented activities. According to one student, "We had a unit on lab procedures, but what if we have to communicate with a patient who speaks English about how a partial

denture will be fitted?" (Participant 7). Observations during collaborative group work also indicated that while participants could manage routine tasks, they sometimes struggled to articulate more complex processes in English, suggesting a gap between existing exercises and the demands of advanced or specialized procedures.

These findings emphasize that TEEL materials become significantly more relevant when they mirror authentic clinical and laboratory tasks in the dental technician field. By integrating foundational terminology and higher-level scenario-based exercises, educators can ensure learners are prepared to navigate real-world challenges—whether communicating with international suppliers, collaborating with dentists abroad, or instructing patients on post-procedure care. In essence, aligning TEEL with genuine professional contexts bolsters immediate engagement and comprehension and supports learners' long-term readiness for an increasingly globalized dental industry.

Professional Practice Readiness

The participants reported that TEEL provided a structured platform to practice using specialized terminology in context, thus boosting their ability to explain procedures to peers, instructors, and simulated patients. One student explained, "Before using TEEL, I often confused dental terms. Now, I can explain procedures more confidently in English" (Participant 7). Another participant commented, "I finally understand how to name and discuss complex tools, like polishing burs and impression trays, without mixing them up" (Participant 11), indicating a notable shift toward more straightforward, more accurate communication.

In addition to self-reported gains, classroom observations revealed that students were more willing to participate in simulated patient interactions and technical demonstrations. Participant 2 remarked, "We practiced role-playing with classmates, and it felt like preparing for real patient consultations or overseas collaborations." Echoing this sentiment, Participant 9 noted, "I used to rely on gestures when describing lab processes, but now I use the correct English terms even during group projects." Such accounts underscore that TEEL not only refines language proficiency but also fosters crucial synergy between communicative and practical skills—an essential combination for dental technicians in increasingly globalized healthcare settings.

Challenges in Technology Integration

It stood out as a recurring concern among the 15 dental technician students interviewed, specifically regarding limited device access, inconsistent internet connectivity, and difficulties adapting to digital learning tools. Participant 6 highlighted the positive impact of simulations—"The simulations helped me practice how to explain dental treatments to patients. I feel more confident using English in a professional setting now."—others faced obstacles in getting started. Participant 4 recalled, "It was hard to use the app at first because I didn't know where to begin," pointing to a need for clear initial guidance. Technical issues often exacerbated such confusion, as Participant 9 admitted, "Our campus Wi-Fi is weak, so I get kicked out of the app sessions a lot, which breaks my focus." Observations confirmed that in some lessons, students lost considerable time troubleshooting rather than practicing specialized English or honing lab skills. Participant 11 commented, "My home internet isn't stable enough to run the simulations, so I fall behind on the exercises." This sentiment reflects a broader challenge in balancing technical demands

with the already rigorous nature of dental technician training. These experiences underscore the importance of reliable infrastructure, user-friendly platforms, and institutional support to ensure that Technology-Enhanced English Learning (TEEL) truly benefits students aiming to master both the language and the specialized competencies required in dental technology.

DISCUSSION

TEEL provides multiple benefits for dental technician students from the ESP perspective by improving access to resources aligned with their professional needs. It enables students to engage with technical content, such as glossaries of dentistry-specific vocabulary, demonstrations of procedures, and 3D models of dental tools. Incorporating authentic materials helps students transition from language learning to practical application. Jeong (2022) states that utilizing digital devices can support language learners in acquiring communicative competence, meeting their learning needs, and engaging in authentic communication from meaningful and sustainable perspectives. For instance, videos demonstrating dental procedures enhance comprehension of complex terminology, while simulated patient interactions and real-world case scenarios immerse students in professional environments (Elendu et al., 2024). Moreover, TEEL supports self-paced learning by allowing students to follow customized pathways through adaptive learning software (Bayly-Castaneda et al., 2024). Learning content should be tailored to individual needs, balancing complexity and quantity to prevent cognitive overload (Hill & Miller, 2013; Chen, 2022). For example, an app can introduce advanced dental vocabulary only after mastering foundational knowledge. Additionally, TEEL enables flexible access to learning materials, removing the time constraints associated with traditional classrooms. Many students value online lesson reviews and mobile learning, as these facilitate continuous education—especially for vocational students managing academic and work responsibilities (Mahande et al., 2017; Criollo-C et al., 2021; Serdyukov, 2017).

The TEEL approach enhances motivation and engagement through gamified quizzes, multimedia exercises, and role-play simulations. These activities make learning interactive and enjoyable while reducing academic stress (David & Weinstein, 2023; Mulyadi et al., 2023). Classroom observations show higher engagement when students use digital tools to compete in challenges or collaborate in teams (Wang & Huang, 2023). Maintaining student participation is essential in preventing disengagement or dropout. Additionally, TEEL prepares students for professional settings by offering digital role-play exercises that simulate real-world interactions (Adipat et al., 2021; Urbaite, 2024). These exercises build linguistic fluency and confidence in using English in workplace situations, such as patient consultations and team communication. Students report feeling more prepared for internships and future careers after practicing simulated patient encounters.

Besides, difficulties and challenges were common themes across students' work and interview responses, highlighting barriers to integrating TEEL into their learning experience. While TEEL offers benefits in language proficiency and professional preparation, it also presents limitations, primarily related to accessing resources and adapting to new digital tools. Addressing these challenges is crucial for effectively implementing technology in vocational training, particularly dental education (Nassar & Tekian, 2020).

A key barrier identified was access to technology. Students faced issues with slow internet connectivity and incompatible devices, limiting their ability to use digital tools

effectively (Gkrimpizi et al., 2023; Deiniatur & Cahyono, 2023). Many lacked a stable internet connection, and not all had access to high-quality devices such as tablets, laptops, or smartphones, essential for utilizing multimedia-rich TEEL resources. In particular, reliance on shared devices restricted learning opportunities, as students could not always access the tools when needed. Without proper guidance, the initial stages of the course were frustrating and slow for some learners. Bitar and Davidovich (2024) and Palacios-Rodríguez et al. (2023) emphasize that these difficulties underscore providing technical and pedagogical support to ensure a smooth transition to digital learning. Clear instructions and structured training could help students navigate new tools more effectively. Additionally, a lack of digital skills further compounded these challenges. While students were often tech-savvy in their personal lives, many lacked the academic digital skills necessary to maximize TEEL's interactive features, such as quizzes, simulations, and role-playing exercises. Huang et al. (2023) argues that without adequate training, students risk missing out on the full benefits of technology-enhanced learning, which requires a certain level of digital fluency. Preparing students with foundational digital skills before engaging in TEEL interventions would help them maximize these learning opportunities.

Despite demonstrating the benefits of TEEL in vocational ESP instruction, this study has several limitations. The small sample size, limited to fifteen students from a single institution, restricts the generalizability of the findings. Additionally, while providing rich insights, the reliance on qualitative data may be subject to participant bias and lacks objective measurement of learning outcomes. Unequal access to digital tools and varying levels of digital literacy also influenced students' ability to engage with TEEL effectively. Moreover, the study focused on structured classroom activities, leaving gaps in understanding how well students transfer TEEL-acquired skills to real-world dental practice. Future research should explore AI-driven adaptive simulations to enhance spontaneous communication, expand TEEL's application to other vocational fields, and integrate real-time assessment tools to measure students' proficiency in professional contexts. Addressing digital literacy gaps and improving access to technology through institutional support should also be prioritized to maximize TEEL's impact. Longitudinal studies tracking students' workplace language use would further clarify TEEL's long-term effectiveness in vocational education.

CONCLUSION

This study demonstrates that Technology-Enhanced English Learning (TEEL) significantly improves dental technician students' ability to acquire and apply professional English vocabulary. Integrating interactive simulations, role-playing exercises, and digital glossaries enhanced student engagement and boosted their confidence in workplace communication. The findings emphasize that TEEL resources explicitly tailored to the dental field are more effective than generic language-learning tools, reinforcing the importance of ESP-based approaches in vocational education.

While TEEL proved beneficial in enhancing professional readiness, challenges remained, particularly regarding limited access to dental-specific content and the structured nature of role-playing simulations, which restricted students' ability to handle spontaneous real-world interactions. Future research should explore the development of AI-driven adaptive simulations that allow students to engage in more dynamic and responsive

professional conversations, better preparing them for unpredictable workplace scenarios. Additionally, integrating real-time assessment tools will provide a more accurate measure of students' ability to apply English effectively in dental practice.

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