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WEB-BASED CLIL FOR ORACY DEVELOPMENT: A CASE STUDY IN ENGINEERING EDUCATION

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Abstract
This paper was intended to explore how web-based Content and Language Integrated Learning (CLIL) was used as a task and a tool for oracy growth in mechanical engineering education. The participants were purposively selected to represent varying levels of CLIL engagement and English proficiency, consisting of one English instructor and three second-semester mechanical engineering students from Pancasakti University, Tegal. Data were collected via semi-structured interviews and document analysis of lesson plans, followed by thematic analysis to interpret the findings. The results showed that web-based CLIL improved students' spoken English skills and helped them to understand engineering ideas by means of real-time films, simulations, and online materials. Moreover, various challenges persisted, particularly at Common European Framework of Reference for Languages (CEFR) levels A2–B1, where they hindered comprehension, language production, and equitable digital access. To foster more inclusive and effective CLIL implementation, this paper highlighted the need for explicit scaffolding strategies, dual-focused assessment rubrics, and thoughtful syllabus revision. The findings highlighted the need of professional development and lecturer facilitation in maximizing the incorporation of CLIL for oracy in engineering environments.

Keywords: engineering education, oracy development, resource, task, web based CLIL

Introduction

Originally developed in Europe during the 1990s, Content and Language Integrated Learning (CLIL) emerged as a dual-focused approach to instruction that uses a foreign language as the medium for teaching content subjects. As global demands for discipline-specific English proficiency grow, CLIL has increasingly overlapped with English for Specific Purposes (ESP), especially in technical fields like mechanical engineering where language is used for navigating complex systems, tools, and research (Luo & Garner, 2017). Unlike traditional ESP programs that often isolate language instruction from content, CLIL fosters integrated learning environments that engage students in both conceptual understanding and authentic language use. Recent studies confirm that CLIL enhances learners' motivation and language performance more effectively than traditional foreign language instruction, particularly when it leverages multimodal input, dialogic interaction, and purposeful communication (Dalton-Puffer, 2016; Sato & Hemmi, 2022; Chen et al., 2024). These pedagogical affordances are especially relevant for higher education contexts that require both communicative competence and academic literacy in globalized disciplines.

Responding to these international trends, the Mechanical Engineering Department at Pancasakti University, Tegal has begun developing an English curriculum aligned with the communicative and

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cognitive demands of the profession. In this setting, English proficiency is essential for accessing technical documentation, engaging with international stakeholders, and contributing to collaborative research. The department's program aims to produce graduates proficient in materials science, mechanical systems design, and thermal-fluid processes, all of which require both conceptual clarity and professional-level English. Within this framework, Web-based CLIL becomes particularly relevant. Integrating digital simulations, industry-authored manuals, and multilingual multimedia supports the development of CEFR-aligned oracy outcomes and bridges the gap between local expertise and global communication (Kaewkamnerd et al., 2023; Begimbetova et al., 2022). Moreover, web-enhanced CLIL environments allow students to interact with multimodal input, engage in real-world engineering scenarios, and build critical thinking skills through collaborative dialogue (Chen et al., 2024; Sato, 2024). This makes CLIL not only a method for language learning but also a strategy for cultivating the communicative agility and technical fluency required in twenty-first-century engineering education.

This study is built upon these developments by exploring how Web-based CLIL can operationalize CEFR-aligned oracy instruction in technical higher education contexts. While prior research has outlined the benefits of CLIL-ESP integration and proposed hybrid rubrics for technical communication, limited attention has been given to how such frameworks function when delivered through digital media in locally situated engineering programs. This research addresses that gap by examining how CEFR-informed speaking tasks, when supported by web-based tools, can facilitate oracy development in mechanical engineering education at Pancasakti University, Tegal. It aims to offer a pedagogical model that connects multimodal CLIL input, CEFR progression, and integrated assessment practices tailored to disciplinary demands. In light of these objectives, the central research qwas to find out how Web-based CLIL was utilized as both a task and a pedagogical tool to develop oracy in technical English among engineering students at Pancasakti University, Tegal

Literature Review

Oracy in CLIL-ESP contexts

Oracy in CLIL-ESP environments is not limited to fluent speech; it includes the ability to produce contextually appropriate, disciplinary-specific language in real-time interaction. Nguyen & Tran (2023) affirmed that oracy must be situated in authentic communicative scenarios where learners simultaneously construct content knowledge and professional identity. This view aligns with Hüttner & Smit's (2014) assertion that spoken discourse in CLIL should mirror the epistemological norms of the discipline being taught, particularly in technical fields such as mechanical engineering where students are expected to explain, justify, and critique procedures using precise terminology.

Recent studies reinforced that oracy emerges most effectively when language production is tied to disciplinary problem-solving. Sato & Hemmi (2022) show that learners exhibit greater fluency and syntactic control when engaged in cognitively demanding tasks with high communicative stakes, such as project presentations and collaborative troubleshooting. These findings are echoed by Tatiana et al. (2019), who emphasized that web-based learning environments enhance this process by providing flexible, multimodal inputs that simulate professional interactions. Moreover, Mukminatien et al. (2020) confirmed that oracy gains are highest when students are encouraged to engage in extended discourse through structured dialogue tasks relevant to their technical specialization.

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Synthesizing these perspectives, it becomes clear that CLIL-ESP must move beyond discrete language skills to embed oracy in socially meaningful, content-rich practices. Oracy in this context becomes a mode of doing engineering, not merely talking about it. When students are required to articulate solutions, ask questions, or critique peer designs, they internalize both disciplinary reasoning and the communicative norms required in real-world settings. Fadlia et al. (2022) and Arnó-Macià & Mancho-Barés (2015) further supported this by emphasizing that disciplinary speaking tasks help shape students' transition from learners to novice professionals. Thus, in the CLIL-ESP classroom, oracy is not an add-on skill but a central vehicle of professional enculturation.

While these studies highlighted the value of oracy-oriented CLIL tasks, few have focused specifically on web-based environments with CEFR integration in vocational engineering education. This study addresses that gap by examining how web-based CLIL supports oracy development among CEFR A2–B1 mechanical engineering students in an Indonesian university context. By combining interview data and lesson plan analysis, the research provides grounded insights into how digital tasks facilitate spoken technical communication while revealing barriers such as uneven digital access and limited scaffolding for low-proficiency learners.

The role of CEFR in structuring technical oracy

The integration of CEFR into CLIL-ESP design has become a powerful strategy for aligning language instruction with the specific communicative demands of technical fields. Redlich & Pattison (2024) argue that CEFR descriptors provide not only progression benchmarks but also design templates for real-life performance tasks. In engineering CLIL, these descriptors can be recontextualized into outcomes such as describing component functionality using domain-specific terms or formulating design justifications in formal team meetings. Kaewkamnerd et al. (2023) supported this approach by showing that CEFR-based speaking tasks enhance students' ability to express technical ideas with both linguistic precision and rhetorical coherence.

Furthermore, CEFR descriptors promote a shift from general language goals toward professional communication functions. Jiménez-Muñoz (2014) and Lo & Lin (2015) found that CEFR-informed instruction in tertiary ESP settings helped learners identify performance gaps and set specific oral development goals across formal and informal registers. In Indonesia, Mukminatien et al. (2020) operationalized this by mapping CEFR scales to tasks such as oral instructions, simulated interviews, and equipment explanations, effectively contextualizing the CEFR within the technical realities of vocational education.

Importantly, this alignment supports transparent and formative assessment. Instead of abstract speaking grades, instructors can evaluate learners on CEFR-informed rubrics that reflect both linguistic and functional adequacy. Fleta (2023) underscored the importance of observable descriptors in evaluating scientific oracy, which translates well into higher education through clear expectations and scaffolded performance. By linking CEFR descriptors with actual speaking events in technical contexts, teachers can track development more meaningfully and students can monitor their own growth with increased agency. In sum, CEFR serves as a linguistic bridge between classroom oracy practice and the communicative demands of engineering workplaces.

However, limited research has examined how CEFR-aligned CLIL tasks were implemented in fully online settings for low-intermediate learners in engineering fields. This study addressed that gap by investigating how CEFR-based oracy goals were operationalized through web-mediated CLIL instruction among Indonesian mechanical engineering students at the A2–B1 level. It offers new

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insights into how digital platforms can support or constrain oracy development when integrated with performance-based CEFR descriptors in a vocational context.

Challenges in CEFR-based CLIL assessment

While CEFR-based models bring much-needed structure to CLIL-ESP oracy instruction, several pedagogical tensions remain unresolved. One persistent issue is the risk of content simplification when language descriptors are rigidly applied. Costa & Coleman (2010) and Airey (2016) argued that in highly technical disciplines, reducing conceptual complexity to accommodate lower language levels can distort content authenticity. This tension is echoed in the findings of Wilkinson (2018), who notes that content lecturers often avoid rich disciplinary dialogue to prevent overwhelming learners linguistically.

Further studies point to a mismatch between oracy task design and assessment practices. Sato & Hemmi (2022) observed that while oracy is emphasized in CLIL syllabi, performance criteria are rarely made explicit, resulting in student uncertainty and limited constructive feedback. Similarly, Lee (2021) reports that instructors struggle to assess both content knowledge and linguistic competence concurrently, especially without institutionally supported rubrics. In the absence of clear evaluative tools, teachers tend to prioritize one domain over the other, which weakens the integrated objective of CLIL. One solution lies in developing integrated rubrics grounded in both CEFR and the 4C framework. Redlich & Pattison (2024) and Kaewkamnerd et al. (2023) proposed hybrid criteria that combine content logic, task relevance, and communicative clarity. Oracy tasks can be assessed using descriptors such as explaining technical concepts using appropriate vocabulary and sequence or responding to technical questions with logical elaboration. When aligned with CEFR progression and content accuracy, such rubrics offer a more holistic and transparent measure of technical oracy. Finally, the institutional dimension must be addressed. Lo & Lin (2015) argued that sustainable CLIL assessment depends on long-term investments in teacher professional development and curricular harmonization. Without these structural supports, CEFR may remain a theoretical reference rather than a fully operational tool. Institutions must thus commit to providing pedagogical and assessment training that helps teachers confidently integrate CEFR into their practice without compromising content rigor or instructional coherence.

However, existing studies have yet to explore how CEFR-based oracy frameworks are operationalized in online CLIL-ESP classrooms at the vocational level, particularly within Indonesian contexts. While the literature offers valuable models for task design and integrated rubrics, there remains a need to examine how instructors interpret, adapt, and implement these tools in real-time digital instruction. This study addresses that gap by investigating classroom practices that embed CEFR descriptors into oracy-focused tasks for A2–B1 engineering students. It seeks to uncover how teachers balance linguistic scaffolding with disciplinary authenticity in facilitating students' spoken performance online.

Methodology

Research design and approach of the study

This paper applied a qualitative case study technique to evaluate using Web-Based CLIL as a task and resource for oracy development in mechanical engineering education. A case study was

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chosen since it allows one to examine closely real-world learning contexts (Banegas, 2022; Méndez García, 2012). Keeping a specific context in mind, this study was aimed to clarify how web-based tools enable students to raise their English technical communication competency.

Research site and participants

The subjects of this study were one class of Mechanical Engineering program for class observation, one English teacher, and three second-semester mechanical engineering students. Pancasakti University, Tegal was chosen since CLIL was used in the curriculum. The teacher was selected based on his/her participation in CLIL training and English for Specific Purposes (ESP) experience teaching. Purposive sampling as inspired by Campbell et al. (2020) was applied in choosing the students. The criteria were that they had experience with technological oracy assignments and web-based learning. In addition, they were also recommended by their lecturer based on their performance during courses and had interacted with CLIL-based learning displaying a range of competencies as well as their degrees of English competency and their experience with CLIL i

Data collection and analysis

To address the research questions concerning how web-based CLIL supports oracy development in mechanical engineering education, data were collected through semi-structured interviews and documents. The interviews, conducted either online or in person depending on availability, involved both lecturers and students. For lecturers, the questions explored their strategies in integrating web-based CLIL, challenges encountered during implementation, and perceptions of its effectiveness in enhancing students' oral communication. From the students' perspective, the interviews investigated their engagement in online-based projects, perceived gains, and barriers in practicing technical spoken English. All interviews were recorded, transcribed, and analysed using thematic analysis (Braun & Clarke, 2006).

To triangulate findings and enrich contextual interpretation, the study also examined Semester Lesson Plans (*RPS*) used in the mechanical engineering English curriculum. The document analysis focused on identifying learning objectives related to oracy, the extent to which web-based resources were integrated into instruction, and the alignment of these elements with CEFR-based CLIL principles.

Thematic analysis was applied to both interview transcripts and instructional documents. This process began with immersion in the data through repeated reading to identify initial patterns. Systematic coding was then conducted to classify significant issues related to CLIL's 4Cs framework implementation by Coyle et al. (2010). These codes were subsequently grouped into broader thematic categories such as technological affordances, pedagogical challenges, and instructional strategies. The final phase involved interpretive synthesis to understand how online learning activities contributed to students' spoken English development in engineering contexts.

Results

This section presents the findings in alignment with the study's purpose and research questions, which focus on how web-based CLIL supports oracy development in mechanical engineering education at Pancasakti University, Tegal. Based on data gathered from lecturer and student interviews

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as well as document analysis of course syllabi, the findings illustrate how web-based CLIL enhances students' technical communication through digitally mediated learning experiences. To ensure clarity and coherence, the presentation of findings is organized thematically, with each theme reflecting key dimensions of web-based CLIL implementation in relation to oracy development.

Integration of Web-Based Resources

Pancasakti University Tegal's Mechanical Engineering Program's integration of web-based resources demonstrated how important digital technology was to enhancing students' educational experiences. This data were derived from lectures and student interviews, as well as document analysis of course syllabi, to illustrate how online platforms like video simulations, real-world engineering websites, and digital-based assignments were used to enhance students' understanding of technical concepts, exposed them to real-world industry terminology, and developed their problem-solving skills. The table below displayed the main themes that emerged from the data, supported by direct quotes that highlighted the application of web-based resources in university engineering education.

Table 1. *Summary of interview and document analysis results of theme 1*

Participants	Sub-Themes	Codes	Quotes from Participants
Lecturer	Use of online videos and simulations	Visual learning, interactive media	*"YouTube channels like CrashCourse and FD_Engineering are frequently used by me since they offer visual aids to improve students' grasp of technical ideas."*
Student 1	Use of online videos and simulations	Concept reinforcement, engaging content	*"Reading books alone does not help me understand difficult ideas; watching videos on the Domain of Science Channel does."*
Student 2	Technical terminology acquisition	Authentic materials, industry vocabulary	*"Websites like Eastern Engineering Group expose me to routinely used real-world engineering terms used in the field."*
Lecturer	Task-based learning with web resources	Web-based assignments, problem-solving	*"I give students mechanical assignments where they calculate engineering parameters and share their results in class."*
Student 3	Task-based learning with web resources	Hands-on learning, digital tasks	*"Seeing the calculations in action helped me grasp formulas better using mechanical tools."*
Lecturer	Instructor's role in web-based resource integration	Content curation, scaffolding	*"I make sure the internet tools give students organized direction and complement course objectives to enable their effective engagement."*

Based on the table, the syllabus suggested that students could connect with online resources on their own, which would disadvantage those whose English competency falls short of A2 CEFR level. In addition, a strategy for evaluating spoken communication needs to be developed, even if the curriculum includes web-based assignments, highlighting the need for rubrics that assess both digital task performance and spoken fluency. Along with systematic recommendations on how students should engage with web-based resources to guarantee the development of technical and language competencies in line with the CLIL approach, the curriculum should include adequately defined oral assessment criteria.

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Oracy Development through Web-Based CLIL

The university's Mechanical Engineering Program's Web-Based CLIL (Content and Language Integrated Learning) approach places a high priority on assisting students in improving their oracy skills, or their ability to express technical ideas orally in English. This section presents the results of interviews and document analysis that looked at the benefits and drawbacks of using digital and multimedia resources to improve students' oral communication. Themes like task complexity, comprehension difficulties, assessment concerns, and learner confidence were examined in light of students' experiences and teachers' pedagogical approaches. The following table, which highlights these emerging sub-themes and is supported by direct participant quotes and syllabus analysis, offers a thorough understanding of oracy development in a CLIL-oriented engineering context.

Table 2. *Summary of interview and document analysis results of theme 2*

Participants	Sub-Themes	Codes	Quotes from Participants
Lecturer	Task complexity	Difficulty in structuring tasks	*"Students sometimes struggle with organizing their responses when given open-ended tasks based on movies."*
Lecturer	Task complexity	Balancing content and language focus	*"Sometimes they neglect appropriate language use in their spoken responses and concentrate too much on technical aspects."*
Student 1	Comprehension issues	Fast-paced video content	*"Some movies have too much information at once, which makes effective summarizing challenging."*
Student 2	Comprehension issues	Accent and terminology challenges	*"It's difficult to accept several English accents, particularly in technical videos."*
Student 3	Task difficulty	Nervousness in oral tasks	*"Presenting an engineering report in English is threatening since I am afraid of making mistakes."*
Lecturer	Assessment challenges	Difficulty in evaluating speaking performance	*"Assessing technical accuracy and language proficiency in presentations is complex."*
Student 2	Task execution	Lack of confidence in role-playing	*"The role-play on job interviews was interesting, but I felt nervous since I was not sure how to express myself correctly."*

Based on the table, the course syllabus recognized the need of oracy growth by means of presentations, role-playing, and video-based interactions. Interview results, however, highlighted to challenges students face completing these assignments, notably in terms of arranging responses, juggling language and content, and overcoming understanding difficulty brought on by dialect differences and the fast-paced character of online films. Besides, the lecturer underlined as a main obstacle the assessment of oral performance, in which technical accuracy and language competency have to be assessed simultaneously. Since the curriculum does not provide a clear criteria or direction for assessing these two dual traits, it makes it difficult for teachers to provide targeted remarks.

Furthermore, in presentations and role-playing, lower CEFR competency levels (A2-B1) also caused students have more anxiety in speaking assignments. Although the syllabus comprises of spoken work, it did not offer clear scaffolding strategies to let students progressively gain confidence in spoken communication. To cover these deficiencies, the syllabus should include clear the

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assessment criteria for both language and topic competence in web-based CLIL assignments, organized answer frameworks, and step-by-step speaking exercises.

Challenges in implementing Web-based CLIL

Despite its potential, Web-Based CLIL implementation in the Mechanical Engineering Program at Pancasakti University, Tegal faced several pedagogical and technical challenges. This section outlines the difficulties teachers and students encountered when integrating online resources with language and content learning. The data, which obtained from interviews and the examination of course materials, revealed recurring issues such as task complexity, comprehension hurdles, insufficient feedback, gaps in language proficiency, and infrastructure constraints. These challenges lessen the overall effectiveness of CLIL-based education by limiting students' ability to engage in oral activities in a meaningful way. The table below highlighted these concerns and offered insight into the practical limitations of incorporating Web-Based CLIL in practice through sub-themes and illustrative quotations.

Table 3. *Summary of interview and document analysis results of theme 3*

Participants	Sub-Themes	Codes	Quotes from Participants
Lecturer	Task complexity	Difficulty in structuring tasks	*"Students sometimes struggle with organizing their responses when given open-ended tasks based on movies."*
Lecturer	Task complexity	Balancing content and language focus	*"Sometimes they neglect appropriate language use in their spoken responses and concentrate too much on technical aspects."*
Student 1	Comprehension issues	Fast-paced video content	*"Some movies have too much information at once, which makes effective summarizing challenging."*
Student 2	Comprehension issues	Accent and terminology challenges	*"It's difficult to accept several English accents, particularly in technical videos."*
Student 3	Task difficulty	Nervousness in oral tasks	*"Presenting an engineering report in English is threatening since I am afraid of making mistakes."*
Lecturer	Assessment challenges	Difficulty in evaluating speaking performance	*"Assessing technical accuracy and language proficiency in presentations is complex."*
Student 2	Task execution	Lack of confidence in role-playing	*"The role-play on job interviews was interesting, but I felt nervous since I was not sure how to express myself correctly."*
Lecturer	Language proficiency gaps	Low CEFR levels	*"Some students are still at A2 or B1 level, so they find it difficult to follow CLIL-based tasks requiring independent speaking."*
Student 1	Limited feedback	Need for more corrective support	*"I wish we had more comments on how to polish our technical vocabulary and pronunciation."*
Student 3	Technical constraints	Internet and device issues	*"Sometimes slow internet or limited device capabilities cause us trouble finding online materials."*

One of the key issues was task complexity since students struggle to organize responses in open-ended speaking activities reliant on video materials. Many students, the instructor noted, ignored language accuracy in lieu of technical substance, which produced unequal oral presentations. Foreign accents in engineering-related videos and fast-paced video content also generated comprehension issues that make it difficult for students to effectively summarize content.

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Variations in student linguistic competency offer still another significant challenge. Many students still fell in CEFR A2–B1 levels, which reduced their ability to provide confident CLIL-based speaking tasks. Especially when they had to communicate challenging engineering concepts in English, they thus get nervous in technical presentations and role-playing exercises. This is in line with the syllabus outcomes, which lacked explicit scaffolding mechanisms to support language development, including guided response frameworks or orderly feedback systems. Examining linguistic correctness concurrently with technical knowledge presents challenges for evaluating speaking ability as well. Although the syllabus emphasized on oral evaluation components, it did not offer clear rubrics to differentiate fluency, pronunciation, and technical accuracy, so it was difficult to offer targeted remarks.

Technical constraints on devices and internet connectivity issues finally prevented students from routinely access to online resources. The curriculum contained digital tools, but it did not offer instructions for effective interaction with web-based resources, therefore maybe generating passive rather than participatory learning opportunities. To bridge these gaps, the curriculum should have well defined assessment criteria for oral activities, step-by-step speaking scaffolding, and explicit guidelines on accessing internet resources for oracy development. Furthermore, the curriculum should include more ordered feedback systems to help students increase their technical vocabulary and pronunciation.

Role of lecturer in facilitating CLIL

The role lecturer was crucial to the effective use of Web-based CLIL in the Mechanical Engineering Program at Pancasakti University, Tegal, particularly when it came to help students advance their language and technical proficiency. This section presented evidence from participant interviews and syllabus documents of the various teaching strategies used by lecturers, including scaffolding tasks, giving corrective feedback, promoting classroom interaction, and adapting to students' English proficiency levels. Despite evident efforts, the analysis also demonstrated the limited formal integration of these roles into the assessment criteria and course design. Along with participant quotes and curriculum insights that highlighted the benefits and drawbacks of CLIL facilitation, the table below listed the sub-themes related to the lecturer's role.

Table 4. *Summary of interview and document analysis results of theme 4*

Participants	Sub-Themes	Codes	Quotes from Participants
Lecturer	Task design	Scaffolding for oral tasks	*"Before asking children to present, I provide structured guidelines and model responses."*
Lecturer	Language support	Corrective feedback	*"I provide comments on both technical accuracy and language use; but, balancing the two is difficult."*
Lecturer	Motivational strategies	Encouraging active participation	*"I try to set up a conducive atmosphere where students feel free to express even if they make mistakes."*
Student 1	Guidance in learning	Clarifying engineering concepts	*"The lecturer guides us in properly expressing technical terms in English."*
Student 2	Classroom interaction	Questioning techniques	*"we are asked to explain ideas in our own words often, which improves our speaking fluency."*
Student 3	Scaffolding	Role of demonstration	*"it helps us to do the work ourselves when the lecturer shows how to examine a video."*

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Lecturer	Assessment strategies	Balancing content and language evaluation	*"it's tough to evaluate in students' presentations both the engineering accuracy and fluency."*
Student 1	Role of lecturer	Adapting to student needs	*"the lecturer helps a lot by varying the challenge of tasks depending on our english level."*

The role of lecturer was highly crucial in scaffolding oral activities by providing disciplined guidelines and sample responses before students engaged in speaking events. This is in line with CLIL concepts, which underline delayed support in merging content with language acquisition. Though it could lead to differences in instructional delivery, the course syllabus does not particularly mention exact step-by-step scaffolding techniques. Besides, the lecturer still had another crucial duty to offer corrections on technical content and language use. While students liked this double approach, the lecturer pointed out the challenge in balancing technical accuracy with fluency evaluation. The syllabus generally emphasized topic knowledge above language fluency, which could cause unequal development of students' speaking competencies.

Besides, the lecturer had to evaluate engineering precision as well as speaking fluency, hence assessment methods remain challenging. Lack of exact criteria for assessing students' speaking performance holistically resulted from the syllabus giving technical material higher priority than language fluency. By more balanced approach to assessment design containing defined weightings for fluency, pronunciation, and technical accuracy, more thorough learning results might be guaranteed. These holes in the curriculum should be closed with structured scaffolding strategies, thorough assessment rubrics for speaking tasks, and interactive approaches aligned with Web-Based CLIL concepts.

Discussion

The integration of web-based resources into Content and Language Integrated Learning (CLIL) within mechanical engineering education revealed significant pedagogical potential, particularly for enhancing both content mastery and oracy. As a dual-focused educational approach, CLIL requires simultaneous attention to subject knowledge and language development. Instructors had increasingly adopted online platforms such as Eastern Engineering Group, Mechanicalc, CrashCourse, and FD Engineering to provide authentic, multimodal input. These platforms offered real-world contexts that bridge theory and practice, facilitating cognitive and communicative engagement with engineering concepts. This practice aligns with the CLIL 4Cs framework (Content, Communication, Cognition, and Culture) that encouraged students to process complex material while articulating it through meaningful language use (Coyle et al., 2010). Empirical evidence that supported this strategy, suggested that multimodal scaffolding could significantly improve comprehension and language fluency when integrated into CLIL classrooms (Ruiz de Zarobe, 2015; Sato & Hemmi, 2022). Furthermore, these resources promoted technical vocabulary acquisition in context-rich environments, strengthening the link between academic discourse and professional relevance (Moore, 2009; Fan-Wei, 2018).

Task-based instruction emerges as a complementary strategy, with learners engaging in group discussions, problem-solving tasks, and oral presentations using English. These activities mirrored the pedagogical intentions of CLIL by embedding communication within disciplinary thinking (Denman et al., 2022). Instructors served not only as knowledge transmitters but also as designers of tasks and facilitators of language use (Kim & Lee, 2020). However, despite these promising practices, the

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findings indicated substantial limitations in the current implementation. Although digital tools were prescribed in the syllabus, insufficient scaffolding often left students without adequate guidance to navigate demanding materials. Video-based resources, while authentic, frequently included fast speech, dense jargon, and unfamiliar English accents, which presented considerable comprehension challenges for learners at CEFR levels A2 or low B1. Without structured support, such as guided viewing strategies or pre-teaching of key vocabulary, students are at risk of cognitive overload and surface-level engagement (Moore, 2009; Lee, 2021).

Moreover, the emotional and cognitive demands of oral production exacerbate these difficulties. Many students expressed anxiety during performance-based tasks like simulated interviews and technical presentations, citing fear of error and lack of linguistic confidence. These findings resonated with previous studies indicating that learners in CLIL settings often prioritize content understanding at the expense of linguistic accuracy, particularly in the absence of targeted support (Wilkinson, 2018; Sato & Hemmi, 2022). The curriculum, while endorsing oracy through role plays and reports, often fails to provide concrete mechanisms such as sample responses, extended wait time, or rubrics for feedback. This gap hinders the development of oral competence and underscores the need for a more explicit pedagogical structure. Additionally, assessment presents a persistent challenge. Teachers report difficulty in evaluating both content and language simultaneously, especially without integrated rubrics that capture the dual aims of CLIL (Kim & Lee, 2020). As a result, feedback became inconsistent, and students received limited direction on how to improve either domain.

Another recurrent issue is the digital divide. Despite the promise of technology to enhance learning, unequal access to devices and stable internet remains a significant barrier. Students reported that hardware limitations and connectivity problems that hindered their ability to engage with online tasks, reflecting broader concerns about equity in tech-assisted education (Li et al., 2024; Pérez Cañado, 2018). Although artificial intelligence tools and mobile applications are increasingly proposed to support autonomous learning, their benefits are conditional upon sufficient digital literacy and institutional support (Yang, 2020; Lo & Lin, 2015). These structural constraints highlighted the importance of considering infrastructure and access when designing CLIL programs that depend heavily on web-based resources.

In light of these complexities, the lecturer's role is central to effective CLIL delivery. Instructors should design scaffolded tasks, model expected language functions, and provide corrective feedback that balances technical and linguistic demands. Scaffolding through structured examples and explicit instruction allows students to internalize both content knowledge and discourse patterns, an approach that is particularly effective for lower-proficiency learners (Meyer et al., 2015; Sato, 2024). Beyond cognitive support, instructors are also responsible for managing affective dimensions of learning. By fostering a psychologically safe environment, they help reduce anxiety and promote active participation. This is consistent with studies showing increased motivation and fluency when learners perceive tasks as meaningful and manageable (Sato & Hemmi, 2022). Instructional adaptability is also crucial, especially in classes with diverse linguistic profiles. Teachers must modify explanations, task complexity, and interaction patterns to ensure inclusivity without compromising content rigor (Fan-Wei, 2018; Lopriore, 2020).

Interactive techniques such as open-ended questioning and extended wait time further enable students to process and articulate ideas in their own words. These strategies activate the cognitive dimension of the 4Cs framework, promoting deeper understanding through verbal elaboration (Moore, 2009). Nonetheless, sustainable CLIL practice requires systemic solutions beyond individual teacher effort. Comprehensive assessment tools, collaborative curriculum planning, and ongoing

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professional development are necessary to bridge the gap between theory and classroom realities. Institutional support is especially vital to ensure that content specialists are equipped to deliver instruction through English with pedagogical precision (Sullivan, 2014). This study underscores the need for CLIL models that are pedagogically robust, digitally inclusive, and responsive to learner diversity. By addressing the dual challenge of content and language integration through strategic use of web-based resources, effective scaffolding, and equitable access, CLIL can serve as a transformative approach to technical education in an increasingly digital and globalized academic landscape.

Despite the valuable insights offered, this study is not without limitations. First, the participant pool was limited to a single cohort of engineering students at Pancasakti University, Tegal, which may constrain the generalizability of findings across broader CLIL contexts or other disciplinary settings. Second, the study was conducted within a specific timeframe and course setting, which may not fully capture longitudinal developments in students' oracy and digital engagement. Third, although data triangulation was employed through classroom observations, student surveys, and interviews, the absence of systematic performance-based assessments (e.g., graded speaking tasks or pre-post tests) limits a more nuanced evaluation of actual language gains. These limitations highlight the need for future research with broader, more diverse samples, longitudinal scope, and mixed-method designs that incorporate both process- and product-oriented measures of learning.

Conclusion and Recommendations/Implications

Web-based CLIL offered substantial potential to enhance oracy development in mechanical engineering education by providing access to authentic digital materials such as simulations, instructional videos, and industry documents that facilitate both technical understanding and English language growth. These resources helped students acquire discipline-specific vocabulary and practice spoken communication in context-rich settings. Nevertheless, the study identified persistent challenges, especially among students with lower CEFR levels, who often struggled with processing complex input, organizing oral responses, and achieving balance between content mastery and linguistic clarity. The findings highlighted the pivotal role of teachers in scaffolding tasks, modeling language use, and delivering focused feedback, yet existing syllabi frequently lack structured mechanisms to support these pedagogical strategies. To address these gaps, curriculum design should include clear rubrics for dual-focused assessment, guided speaking activities, digital accessibility measures, and continuous professional development in CLIL methodology grounded in the 4Cs framework of content, communication, cognition, and culture. Hence, the success of web-based CLIL in promoting oracy depended not only on access to digital tools but also on coherent instructional planning and institutional commitment to equitable and effective learning experiences.

Future researchers are urged to investigate different instructional methodologies and pedagogical support in the application of web-based CLIL particularly for students at lower CEFR levels (A2–B1) who could find real content and oral activities challenging. Additional research might concentrate on creating inclusive digital accessibility policies, providing simulated speaking activities, and building 4Cs-based evaluation rubrics. Furthermore, important to guarantee fair and sustainable development of oracy and technical vocabulary across many learner profiles would be studies on the efficacy of professional development programs for lecturers in CLIL methodology and the integration of technology into engineering curricula.

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