The Implementation of Computer-Assisted Language Instruction in English for Sciences: An ESP Case Study in Higher Education

Ahmed Sardi – Syarifuddin Dollah – Abdullah – Suci Pole Mappaita

DOI: 10.18355/XL.2026.19.01.19

Abstract

This study investigates the implementation of Computer-Assisted Language Instruction (CALI) in English for Sciences within an English for Specific Purposes (ESP) framework through a qualitative case study in a higher education context. Data were collected through classroom observations and in-depth interviews with six EFL lecturers teaching Physics and Mathematics students. The study focuses on the types of digital tools employed, lecturers' ESP-oriented instructional practices, and challenges encountered in integrating CALI into discipline-specific language instruction. The findings indicate that lecturers used multimedia resources, mobile apps, web-based platforms, and emerging AI-powered tools to facilitate the development of scientific vocabulary, reading comprehension, and classroom interaction. CALI-supported instruction enhanced students' behavioral, emotional, and cognitive engagement, as evidenced by increased participation, motivation, and strategic engagement with scientific texts and tasks. Nevertheless, implementation was constrained by infrastructural limitations, limited institutional support, insufficient professional development, and technical issues. Despite these constraints, lecturers demonstrated positive attitudes toward CALI and relied largely on self-directed professional learning. The study concludes that a blended, constructivist-oriented approach is particularly effective for CALI implementation in English for Sciences when supported by adequate institutional policies and resources.

Key words: computer-assisted language instruction, English for sciences, English for specific purposes, EFL lecturers, higher education

Introduction

The rapid development of digital technology has significantly transformed English language teaching, particularly in higher education contexts where Computer-Assisted Language Instruction (CALI) has become an integral part of instructional practice. Since its early adoption in the latter half of the twentieth century, CALI has evolved from drill-based instruction to more interactive, communicative, and learner-centered applications supported by multimedia, web-based platforms, mobile technologies, and artificial intelligence (Aziz et al., 2018; Chapelle, 2001; Levy, 2009; Warschauer, 2000). These developments have expanded opportunities for language exposure, practice, and interaction beyond traditional classroom boundaries, enabling learners to access authentic materials and diverse linguistic inputs.

In English for Specific Purposes (ESP) contexts, particularly English for Sciences, the integration of CALI is increasingly important given the specialized nature of scientific discourse and the growing demand for digital literacy among non-English-major students. Previous studies have demonstrated that CALI can enhance learners' motivation, engagement, and comprehension of scientific texts through multimedia resources, mobile applications, and interactive tasks (Çakır, 2015; Huang, 2020; Mohsen & Shamsiddin, 2017; Yang et al., 2017). These studies suggest that technology-enhanced instruction supports the acquisition of scientific vocabulary and reading skills more effectively than traditional methods alone. However, much of the existing research has primarily focused on learning outcomes, experimental interventions, or specific applications, with less attention given to how CALI is actually implemented by lecturers in real classroom settings.

In developing educational contexts such as Indonesia, the implementation of CALI in higher education presents both opportunities and challenges. While access to digital tools has increased, disparities in infrastructure, internet connectivity, institutional support, and professional development continue to influence instructional practices (Farooq & Soomro, 2018; Hassan & Sajid, 2013; Wedell, 2009). Previous research has identified school-related, system-related, and teacher-related barriers to the integration of technology in EFL classrooms, including limited training, inadequate facilities, time constraints, and uncertainty about selecting appropriate digital resources (Masruddin et al., 2025; Setiadi et al., 2025; Son, 2018). As a result, lecturers often rely on a limited range of familiar tools, such as presentation software, social media platforms, and basic online resources, without fully exploiting the pedagogical potential of CALI.

Despite the growing body of research on CALI, empirical studies examining its implementation in English for Sciences courses, particularly within Physics and Mathematics Education programs at the higher education level, remain limited. Existing studies tend to emphasize technological effectiveness rather than instructional practices, lecturers' decision-making processes, and contextual constraints shaping technology use (Fatimah et al., 2025). Moreover, few studies have explored CALI implementation from the perspectives of EFL lecturers, especially in non-English major programs in Indonesian higher education (three different universities: STKIP Darud Da'wah wal Irsyad Pinrang, Insitut Cokroaminoto Pinrang, and Institut Agama Islam Negeri Parepare). This gap indicates a need for context-sensitive investigations that document how digital tools and applications are selected, utilized, and adapted to meet disciplinary and institutional demands.

Addressing this gap, the present study investigates the implementation of Computer-Assisted Language Instruction in teaching English for Sciences through a qualitative case study in a higher education context. Specifically, the study explores the types of digital tools and applications used by EFL lecturers, examines their instructional practices and attitudes toward CALI, and identifies challenges encountered during technology integration. By focusing on real classroom practices, this study aims to contribute empirical insights into CALI implementation and provide practical implications for lecturers, institutions, and policymakers seeking to enhance technology-supported English instruction in science-related disciplines.

Research Method

Research Design

This study employed a qualitative research approach using a collective case study design to investigate the implementation of Computer-Assisted Language Instruction (CALI) in teaching English for Sciences in higher education. A collective case study was selected because it enables an in-depth examination of a shared phenomenon across multiple bounded cases, allowing for comparison and contextual interpretation of instructional practices (Creswell & Poth, 2018; Yin, 2018). In line with the study's objective, the focus was not on measuring learning outcomes but on understanding how CALI tools and applications are utilized by EFL lecturers in real classroom settings.

Research Sites and Participants

The study was conducted at three higher education institutions in Indonesia: Sekolah Tinggi Keguruan dan Ilmu Pendidikan (STKIP) Darud Da'wah wal Irsyad (DDI) Pinrang, Institut Cokroaminoto Pinrang, and Institut Agama Islam Negeri (IAIN) Parepare. These institutions were selected through purposive sampling based on two criteria: (1) the availability of Mathematics and Physics Education programs, and (2) the integration of technological tools in English for Sciences courses. Preliminary observations conducted in November 2023 confirmed that English lecturers at these institutions actively employed digital tools and applications in their instruction.

Participants consisted of six EFL lecturers (two from each institution) who taught English for Sciences or general English courses to Mathematics and Physics Education students. One class from each study program at each institution was selected to ensure representation across disciplinary contexts relevant to English for Sciences.

Data Collection Techniques

Data were collected through classroom observations, semi-structured interviews, documentation analysis, and field notes to ensure methodological triangulation. Classroom observations were conducted using both structured and participatory approaches. Structured observation focused on specific indicators of CALI implementation, including types of digital tools used, modes of student interaction, and patterns of instructional delivery. Participatory observation enabled the researcher to gain deeper insights into classroom dynamics, student engagement, and challenges emerging during technology-assisted instruction (Cohen et al., 2018; Creswell & Creswell, 2017).

Semi-structured interviews were employed to explore lecturers' experiences, perceptions, and decision-making processes related to CALI implementation. Open-ended questions formed the core of the interviews, allowing participants to elaborate on their instructional strategies, tool selection, and perceived challenges. Follow-up and probing questions were used to clarify responses and elicit richer data (Kvale & Brinkmann, 2009; Rubin & Rubin, 2012). Documentation, including lesson plans, instructional materials, and digital artifacts, was analyzed to support and validate findings from observations and interviews. Field notes were maintained throughout the data collection process to capture contextual details and reflective insights.

Data Analysis

Data analysis followed the interactive model proposed by Miles, Huberman, and Saldaña (2014), which involves iterative and interconnected stages of data condensation, data display, and conclusion drawing.

First, all qualitative data from observations, interviews, and documents were transcribed, organized, and coded. Data condensation involved identifying recurring patterns related to CALI tools, instructional practices, and implementation challenges. Second, data were displayed in thematic matrices and narrative summaries to facilitate cross-case comparison and interpretation. Finally, conclusions were drawn through an iterative verification process that involved cross-checking data sources to enhance credibility and trustworthiness.

Trustworthiness

To ensure rigor, this study employed data triangulation across observations, interviews, and documentation. Member checking was conducted by sharing preliminary interpretations with selected participants to confirm accuracy. These strategies strengthened the credibility and dependability of the findings (Yin, 2018).

Findings

The findings reveal a diverse range of Computer-Assisted Language Instruction (CALI) tools employed by lecturers in teaching English for Sciences. Across participants, the use of CALI appears to be shaped by both pedagogical needs and technological accessibility. Various digital platforms, multimedia resources, and online learning environments are integrated to support different aspects of language learning, particularly vocabulary development, reading comprehension, and interactive practice. Overall, the data indicate that lecturers selectively adopt CALI types they perceive as practical, engaging, and compatible with students' learning contexts.

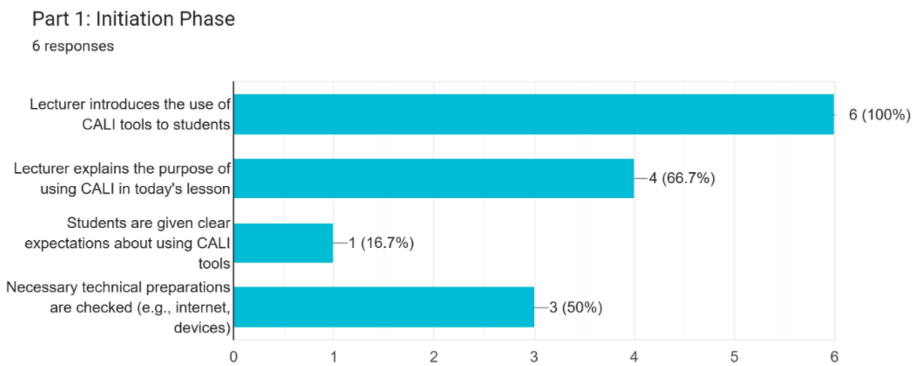

Figure 1. Initiation Phase

The results of the classroom observation during the initiation phase show that most lecturers consistently conducted the initial procedures necessary for integrating CALI into the lesson. All six lecturers (100%) introduced the use of CALI tools to students at the beginning of the session, indicating a strong awareness that students need to be informed about the digital learning environment before starting the lesson. Furthermore, 4 out of 6 lecturers (66.7%) explicitly explained the purpose of using CALI in the current lesson, suggesting that most lecturers helped students understand the instructional rationale for using technology.

However, fewer lecturers provided clear expectations for students' roles during CALI use. Only 1 lecturer (16.7%) set clear expectations regarding how students should engage with CALI, indicating that this component is still underdeveloped in practice. In addition, half of the lecturers (3 lecturers or 50%) ensured that technical preparations such as internet connections and devices were checked beforehand. This implies that technical readiness is not consistently addressed before the lesson, which may affect the smooth implementation of CALI activities.

All in all, the initiation phase demonstrates that lecturers are already strong in introducing CALI tools and explaining their purpose, but setting student expectations and consistently conducting technical checks still require improvement. However, based on the data pattern in the "Initiation Phase," we can infer the type of CALI used but, in this phase, the usage is still introductory (orientation stage), meaning that the dominant CALI tools are typically those that help students:

1. Access materials
2. Log-in
3. View instructions
4. Understand the purpose of the activity

In this phase, lecturers are not yet doing the "main task", yet the CALI tools used are usually platform level tools (learning platform / content interface) rather than high-cognitive AI tools. Interpreted type of CALI used in the Initiation Phase. The tools most likely applied include:

Table 1. CALI used in Teaching EFS for Initiation Phase

Category	Example Platform Type
LMS (Learning Management System) / VLE (Virtual Learning Environment)	Google Classroom, Moodle, Edmodo
Presentation/Delivery	PowerPoint Online, Google Slides
Communication/Instruction	WhatsApp Group, Telegram Group, Zoom Chat
Access to Digital Content	YouTube links, Website links, OER (Open Educational Resources) repository

At this stage, lecturers mostly orient students, hence the lecturers use CALI as a medium for delivering instructions and giving directions, not yet AI-based automation. Use of AI (Artificial Intelligence) in this phase. AI at this phase is minimal as follows; Usually the AI-based CALI appears in the later "Execution" phase (example: Grammarly, QuillBot, ChatGPT, Speech recognition, pronunciation tools, etc.). The chart for Initiation Phase indicates:

1. The focus is on explaining CALI tools, not yet using AI functions
2. Technical readiness checking (internet/device) is still 50%; meaning AI-heavy tools would not yet be appropriate because AI requires very stable connectivity.

The Initiation Phase mainly involved non-AI CALI tools (platform-based tools) because the lecturer's goal was to orient students about the tools, not to activate AI-based functions yet. During the Initiation Phase, the types of CALI involved were mostly platform-based applications such as LMS (e.g., Google Classroom) or web-based content access (e.g., YouTube, online modules, shared documents). At this stage, the lecturers primarily used CALI as a channel for instruction delivery and to introduce learning resources, rather than for automated AI-supported language processing. Therefore, AI-driven tools were not yet dominant in this early stage of the lesson because the focus was on orienting students, explaining the technological purpose, and ensuring device readiness.

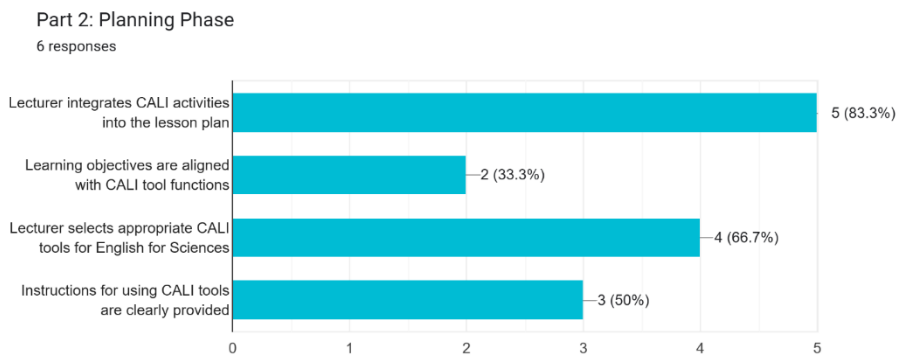

Figure 2. Planning Phase

During the Planning Phase, the majority of lecturers demonstrated adequate preparation related to the integration of CALI into their lesson planning. The data shows that 5 out of 6 lecturers (83.3%) integrated CALI activities into the lesson plan, indicating that the use of digital tools was not incidental, but rather intentionally prepared as part of the instructional design. This suggests that most lecturers already positioned CALI as a planned instructional component, rather than a spontaneous activity.

Furthermore, 4 lecturers (66.7%) were observed selecting appropriate CALI tools specifically for English for Sciences. This implies that the selection of digital tools was not random; instead, lecturers made considerations regarding the relevance of tools to subject-specific needs, indicating a level of pedagogical-technological alignment. However, only 3 lecturers (50%) clearly provided instructions on how the CALI tools should be used. This shows that although planning was done, the clarity of operational communication to students was inconsistent across lecturers. More importantly, only 2 lecturers (33.3%) aligned the learning objectives with specific functions provided by the CALI tools. This suggests that deeper pedagogical alignment linking learning goals to CALI affordances has not been maximized by the majority of lecturers.

While CALI integration at the planning level is generally present, the depth of pedagogical alignment (especially linking tool function to learning objectives) remains limited, indicating room for improvement in instructional design. Lecturers, then, in this phase are likely using:

Table 2. CALI used in Teaching EFS for Planning Phase

Category	Example Applications / Software
Lesson preparation platforms	Google Docs (lesson plan writing), Microsoft Word, Notion
Material preparation tools	PowerPoint / Google Slides, Canva (for slide design)
LMS / VLE for course structuring	Google Classroom, Moodle
Content selection tools	YouTube (choosing videos), online article repositories, OER databases

AI here is used as support for planning, not yet for direct instruction. Possible AI in this phase includes:

Table 3. CALI-AI used in Teaching EFS for Planning Phase

AI Tool Function	Example Apps
Content drafting → generating lesson instructions / prompts	ChatGPT
Checking language accuracy in lesson materials	Grammarly, QuillBot
Creating question banks or task ideas	ChatGPT, Bing Copilot
Vocabulary selection / simplification for specific topics (science terms)	ChatGPT, Elicit

In the planning stage, CALI was utilized mainly for designing lesson structure, selecting appropriate tools, and preparing materials. The use of AI tools was primarily supportive, such as using ChatGPT or Grammarly to refine instructions or generate task ideas, rather than for direct student interaction.

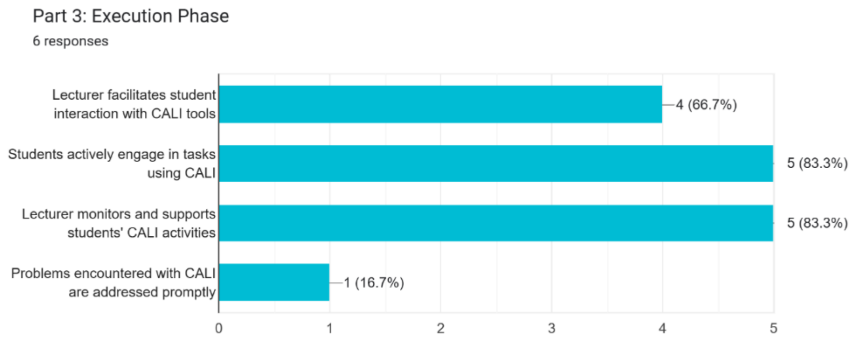

Figure 3. Execution Phase

The observation data for the Execution Phase reveals that CALI was actively implemented during the teaching process. A total of 5 out of 6 lecturers (83.3%) demonstrated that students actively engaged in tasks using CALI tools. This indicates that digital activities were not only planned, but were actually carried out in the classroom, and students were directly involved in interacting with the technology. Similarly, 5 lecturers (83.3%) were consistently observed monitoring and supporting students' CALI-based activities, which shows that lecturers played an active facilitation role rather than leaving students to use the tools independently. In terms of instructor support, 4 lecturers (66.7%) facilitated student interaction with CALI tools, suggesting that although most lecturers assisted students, there were still some lecturers who allowed students to explore with less direct teacher intervention.

Notably, only 1 lecturer (16.7%) was observed addressing CALI-related problems promptly, indicating that troubleshooting and immediate responses to technical problems remain weak points. This suggests that when issues or barriers occurred (e.g., login issues, system lag, wrong menu selection), most lecturers did not immediately provide a technical remedy. And then, the Execution Phase shows that CALI was strongly implemented in classroom activities, with high levels of engagement and monitoring, but there is a substantial gap in the area of real-time problem-solving when technical challenges arise.

In the Execution Phase, CALI moves from planning to actual practice. This is the phase where students actively use digital tools to perform learning activities not just read instructions. Based on typical CALI implementation patterns, the types of CALI and AI that are commonly used in this phase include:

Table 4. CALI-AI used in Teaching EFS for Execution Phase

Function	Example CALI Tools / Platforms
Practicing language skills	Quizizz, Kahoot, Duolingo Web, Memrise
Collaborative writing / editing	Google Docs, Jamboard, Padlet
Research / information access	YouTube science videos, online articles, OER platforms
Presentation sharing	Google Slides, PowerPoint Online
AI-based language support	ChatGPT, Grammarly, QuillBot, DeepL
Pronunciation / speech recognition	Google Speech-to-Text, Elsa Speak

Interpreted that AI becomes visible in this phase. It is because this is the moment where students produce language. In other words, AI during the Execution Phase is used as a learning assistant to support students' writing, vocabulary building, and scientific content comprehension. Examples of possible AI functions used by students at this phase:

Table 5. CALI-AI Features Utilized

AI Feature	Meaning
Grammar/sentence improvement	Grammarly / AI-Rewrite feature
Idea generation / vocabulary selection	ChatGPT prompts
Summarizing scientific texts	AI summarizers (ChatGPT)
Translating academic terms	DeepL / Google Translate AI-enhanced

During the Execution Phase, CALI tools were actively used by students to perform language-learning tasks. In this stage, AI-based applications such as ChatGPT and Grammarly became more visible because students interacted directly with digital systems to generate, revise, and improve their English expressions. This indicates that AI served a functional role as a linguistic support system rather than merely as a delivery medium.

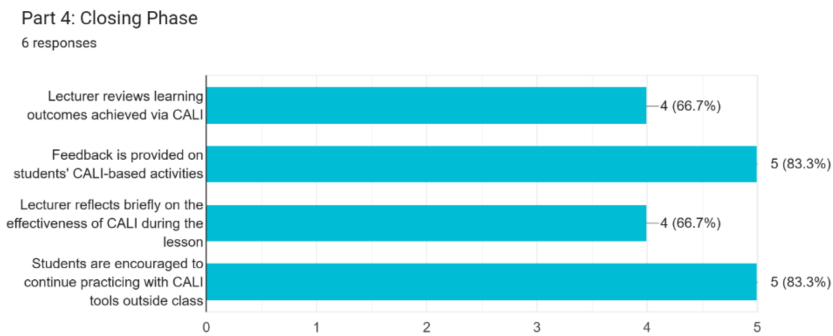

Figure 4. Closing Phase

In the Closing Phase, the observation results indicate that CALI was still utilized as part of the final instructional activities. Five lecturers (83.3%) provided feedback on students' CALI-based activities, suggesting that most lecturers did not end the lesson abruptly but completed the cycle by giving responses or evaluations on students' digital outputs. Likewise, 5 lecturers (83.3%) encouraged students to continue practicing using CALI tools beyond the classroom. This shows that CALI was not only considered an in-class instructional tool but was also used as a self-learning resource outside formal learning time.

Moreover, 4 out of 6 lecturers (66.7%) reviewed learning outcomes achieved via CALI. This indicates that the majority of lecturers connected CALI results back to learning targets, which is important in ensuring accountability between technology use and learning outcomes. In addition, 4 lecturers (66.7%) briefly reflected on the effectiveness of CALI during the lesson. However, this suggests that reflection is still not consistently conducted by all lecturers, some still end their class without evaluating how successful CALI contributed to the quality of teaching and learning. At the end, the Closing Phase reveals that most lecturers were able to close learning activities by providing feedback and encouraging further CALI-based practice. However, reflective evaluation of CALI integration is not yet fully implemented by all lecturers. During the Closing Phase, the lecturer typically focuses on:

1. Reviewing what students have done
2. Giving feedback
3. Checking learning achievement
4. Encouraging further independent practice

Furthermore, the CALI/software used in this stage are mostly feedback-oriented and reflection-oriented digital tools.

Table 6. CALI Types Utilized

Purpose in Closing Phase	Likely CALI / Applications Used
Reviewing students' digital outputs	Google Docs, Google Classroom, Padlet, Jamboard, LMS gradebook
Giving feedback / comments	Google Classroom comment feature, Google Docs comment mode, Microsoft Word track changes
Sharing reflection	Padlet (reflection wall), Mentimeter (reflection poll), WhatsApp group (short reflective messages)
Encouraging independent practice outside class	Links to YouTube videos, OER Science sites, Quizizz homework mode

AI tools in this phase is that AI appears mainly as feedback enhancers and proofing tools. This can be clearly illustrated as follows:

Table 7. CALI-AI Features Enabled

AI Function	Possible Apps
Checking students' accuracy / grammar	Grammarly, QuillBot
Suggesting improvement of students' writing	ChatGPT (rewrite / improve clarity prompt)
Summarizing / paraphrasing scientific text	ChatGPT summarizer tools
Giving vocabulary alternatives for scientific terminology	ChatGPT, DeepL

Regarding the Closing Phase, CALI and AI primarily support feedback and reflection. Instead of generating new content, AI tools are applied to review, comment on, or refine students' outputs, and to suggest improvement strategies for future independent learning. Thus, AI in this stage functions as a post-task evaluation assistant rather than a task-execution assistant.

The findings across the four phases indicate that CALI was integrated systematically and in phases throughout the teaching process, and that AI tools were present but functioned differently at each stage. During the planning phase, digital tools such as Google Classroom, Microsoft Word, and PowerPoint were mainly used for lesson preparation, material curation, and instructional design, while AI tools like ChatGPT and Grammarly were used primarily to assist lecturers in refining materials, generating examples, or paraphrasing content. In the execution phase, CALI was most visible, in which multimedia platforms (YouTube, OER-content websites, Padlet) and interactive applications (Quizizz, Google Forms, Mentimeter) facilitated comprehension, engagement, and practice in scientific English contexts, and AI was used to simplify concepts or provide instant clarification for discipline-specific terminology. Finally, in the closing phase, CALI shifted its role into feedback-and-reflection support, where lecturers used CALI-based comment features (Google Docs comments, Classroom gradebook) and AI feedback tools (Grammarly, ChatGPT rewriting-prompt) to evaluate students' outputs, provide improvement suggestions, and encourage independent practice. Overall, CALI is not only used as a delivery medium, but strategically distributed throughout the instructional cycle, where AI functions more dominantly at two points: (1) during planning to optimize content preparation, and (2) during closing to enhance feedback quality and to refine students' products.

Discussion of the Findings

The findings of this study indicate that the implementation of Computer-Assisted Language Instruction (CALI) in English for Sciences classes follows a systematic and pedagogically sequenced process, encompassing the initiation, planning, execution, and closing phases of instruction. This staged implementation reflects core principles of Computer-Assisted Language Learning (CALL), in which technology is meaningfully embedded within the instructional cycle rather than functioning as a peripheral or supplementary tool (Beatty, 2013). Such an approach demonstrates that CALI supports not only access to learning materials but also communication, comprehension, and disciplinary language development in Physics and Mathematics contexts.

From a digital learning perspective, the findings reveal that lecturers adopt a hybrid digital ecosystem, integrating learning management systems, multimedia resources, collaborative platforms, and selected AI-based applications. This pattern signals a transition from traditional teacher-centered practices toward technology-enhanced, learner-centered instruction, consistent with Technology-Enhanced Language Learning (TELL) and multimedia learning theories. Rather than relying on a single technological solution, lecturers strategically combine multiple tools to address different pedagogical purposes across instructional phases.

CALI in the Initiation Phase: Platform-Oriented Mediation

During the initiation phase, CALI primarily functions as a platform for orientation, instructional access, and classroom communication. All lecturers introduced CALI tools and clarified their purposes, relying mainly on LMS platforms, presentation software, and messaging applications. This aligns with Vygotsky's (1978) concept of mediated learning, in which tools serve as cognitive and social mediators between learners and content. At this stage, technology facilitates contextualization and readiness for learning rather than deep cognitive engagement. The limited use of AI tools is pedagogically appropriate, as AI-supported tasks typically require higher cognitive involvement and stable infrastructure, which may not be immediately available at the outset of instruction.

CALI in the Planning Phase: Authoring and AI-Supported Design

In the planning phase, most lecturers deliberately integrated CALI into lesson design, indicating a shift from incidental to intentional pedagogical planning. Digital authoring tools such as Google Docs, Canva, and LMS platforms were used to structure content, while AI applications supported language refinement, prompt generation, and simplification of scientific terminology. This reflects Authoring Tools-Based Learning, where technology assists educators in creating instructional materials rather than merely delivering content.

From a connectivist perspective (Siemens, 2005), lecturers' reliance on interconnected digital and AI resources illustrates network-based knowledge construction, where instructional design is supported by distributed sources of expertise. However, the limited alignment between CALI functions and explicit learning objectives observed in this phase suggests a gap in pedagogical–

technological integration, reinforcing the relevance of frameworks such as TPACK for strengthening theory-driven technology use.

CALI in the Execution Phase: AI-Driven Language Engagement

The execution phase represents the most intensive use of CALI, with students actively engaging in digital tasks involving reading, writing, pronunciation, and vocabulary development in scientific contexts. Tools such as interactive quizzes, collaborative platforms, multimedia resources, and AI-assisted language applications enabled learners to generate, revise, and evaluate linguistic output. This phase exemplifies AI-based language learning, where students interact with intelligent systems to support language production and comprehension.

Consistent with cognitive constructivist principles, learners actively constructed meaning through interaction rather than passive reception. This finding supports Fredricks et al.'s (2004) engagement framework, particularly behavioral and cognitive engagement, as students demonstrated sustained participation, problem-solving, and strategic language use. Nevertheless, limited lecturer responsiveness to technical issues highlights ongoing challenges related to digital competence and infrastructure readiness, which constrain the transformative potential of CALI.

CALI in the Closing Phase: Reflective and Feedback-Oriented Learning

In the closing phase, CALI shifted toward supporting reflection, feedback, and self-directed learning. Lecturers used AI-assisted tools to provide feedback, review learning outcomes, and guide students in revising their work. This phase aligns with metacognitive learning theory, as learners are encouraged to evaluate their performance and plan improvements. From a sociocultural perspective, AI tools function as scaffolding mechanisms that extend learners' Zone of Proximal Development (Vygotsky, 1978), enabling continued learning beyond classroom boundaries.

Synthesis and Implications

All in all, the findings demonstrate that CALI is implemented in a constructively progressive manner across instructional phases and reflects key principles of CALL, TELL, MALL, constructivism, connectivism, and student engagement theory. While CALI has begun to positively influence engagement and participation in English for Sciences, its impact remains largely functional rather than transformational. Stronger alignment between CALI tools and learning outcomes, enhanced lecturer training, improved infrastructure, and the adoption of systematic pedagogical frameworks such as TPACK or SAMR are necessary to elevate CALI from supportive technology use to transformative instructional practice.

Conclusions and Implications

This study explored the implementation of Computer-Assisted Language Instruction (CALI) in English for Sciences within an English for Specific Purposes (ESP) framework at the higher education level. The findings demonstrate that CALI plays a meaningful role in supporting student engagement across behavioral, emotional, and cognitive dimensions, particularly in facilitating interaction with scientific vocabulary, texts, and task-based activities relevant to Physics and Mathematics. Nevertheless, CALI implementation remains inconsistent, primarily due to infrastructural constraints such as unstable internet access and limited institutional technological resources, which compel both lecturers and students to depend largely on personal devices. Moreover, although lecturers employ a variety of CALI tools including multimedia materials, mobile-assisted applications, web-based platforms, and AI-supported resources; their use is predominantly supplementary and not yet systematically integrated into the formal English for Sciences curriculum.

In terms of implications, the study underscores the need for stronger institutional alignment between ESP-oriented curriculum design and technology-enhanced language pedagogy. Higher education institutions should embed CALI explicitly within English for Sciences syllabi, ensuring that digital tools are purposefully linked to disciplinary language objectives rather than used as add-ons. Sustained professional development is also essential to equip EFL lecturers with pedagogical and technological competencies relevant to ESP instruction. At the policy level, improved digital infrastructure and coherent institutional support are critical to maximizing the linguistic and pedagogical potential of CALI. Future research is recommended to investigate the longitudinal impact of CALI on disciplinary language development and academic literacy in ESP contexts using mixed-methods or multi-site designs.

Declaration on the Use of Artificial Intelligence

This manuscript was prepared by the authors, who retain full responsibility for the originality, accuracy, interpretation, and scholarly integrity of the work. Artificial intelligence–assisted tools (e.g., Grammarly) were employed solely for language refinement and clarity enhancement in selected sections of the manuscript. The use of such tools did not influence the study design, data analysis, interpretation of findings, or the conclusions drawn.

Bibliographic references

Aziz, A. A., Hassan, M. U., & Dzakiria, H. (2018). Growing trends of using mobile in English language learning. Mediterranean Journal of Social Sciences, 9(4), 235-239.

Beatty, K. (2013). Teaching and researching computer-assisted language learning (2nd ed.). Routledge. https://doi.org/10.4324/9781315833774

Çakır, İ. (2015). The use of video as an audio-visual material in foreign language teaching classroom. Procedia - Social and Behavioral Sciences, 199, 67-72. https://doi.org/10.1016/j.sbspro.2015.07.505

Chapelle, C. A. (2001). Computer applications in second language acquisition. Cambridge University Press.

Cohen, L., Manion, L., & Morrison, K. (2018). Research methods in education (8th ed.). Routledge.

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). Sage Publications.

Creswell, J. W., & Poth, C. N. (2018). Qualitative inquiry and research design: Choosing among five approaches (4th ed.). Sage Publications.

Fatmawati-Hani'ah, I. Developing a Creative Writing Approach to Multilingual Literacy in Language Learning: Insights from Indonesia.

Farooq, M. U., & Soomro, A. F. (2018). Teachers and computer technology: Trends in English language teaching in Saudi Arabia. International Journal of English Linguistics, 8(5), 10-19.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. Review of Educational Research, 74(1), 59-109. https://doi.org/10.3102/00346543074001059

Hassan, T. U., & Sajid, A. R. (2013). Computer-assisted language instructions in learning: Problems faced by Pakistan. Journal of Research and Reflections in Education, 7(1), 52-64.

Huang, H.-C. (2020). From web-based readers to mobile-assisted reading: Exploring the impact of mobile technology on EFL learners' reading comprehension and motivation. Computer Assisted Language Learning, 33(3), 1-25. https://doi.org/10.1080/09588221.2019.1614060

Kvale, S., & Brinkmann, S. (2009). InterViews: Learning the craft of qualitative research interviewing (2nd ed.). Sage Publications.
Levy, M. (2009). Technologies in use for second language learning. The Modern Language Journal, 93(1), 769-782.
Masruddin, M., Rusdiansyah, R., Ananda, A. Z., Ermawati, E., & Sardi, A. (2025). Designing English writing worksheets incorporating Islamic moderation values at an Islamic senior high school in Palopo. Studies in English Language and Education, 12(2). https://doi.org/10.24815/siele.v12i2.38115
Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). Qualitative data analysis: A methods sourcebook (3rd ed.). Sage Publications.
Mohsen, M. A., & Shamsiddin, S. (2017). Effects of multimedia glosses on EFL students' vocabulary learning and reading comprehension. International Journal of Instruction, 10(1), 109-126. https://doi.org/10.12973/iji.2017.1017a
Patton, M. Q. (2015). Qualitative research & evaluation methods (4th ed.). Sage Publications.
Rubin, H. J., & Rubin, I. S. (2012). Qualitative interviewing: The art of hearing data (3rd ed.). Sage Publications.
Setiadi, M. A., Basri, M., Sakkir, G., Sardi, A., & Rahman, A. (2025). Students' perceptions of AI-based instruction in academic writing course at an Indonesian private university. International Journal of Language Education, 1(2), 1-20. https://doi.org/10.26858/ijole.v1i2.77294
Siemens, G. (2005). Connectivism: A learning theory for the digital age. International Journal of Instructional Technology and Distance Learning, 2(1), 3-10.
Son, J. B. (2018). Teacher development in technology-enhanced language teaching. Springer International Publishing.
Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.
Warschauer, M. (2000). CALL for the 21st century. In IATEFL and ESADE Conference Proceedings (Vol. 2).
Wedell, M. (2009). Planning for educational change: Putting people and their contexts first. Continuum.
Yang, Y.-F., Gamble, J., Hung, Y.-W., & Lin, T.-Y. (2017). An online adaptive learning environment for critical reading development. Computer Assisted Language Learning, 27(4), 1-23. https://doi.org/10.1080/09588221.2017.1301952
Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). Sage Publications.

Words: 5232
Characters: 39 419 (22 standard pages)

Ahmed Sardi
English Department, Doctoral Program
Universitas Negeri Makassar
Indonesia
ahmed.sardi@student.unm.ac.id
ORCID: 0000-0002-2394-9943

Syarifuddin Dollah
English Department, Doctoral Program
Universitas Negeri Makassar
Indonesia
syarifuddindollah@unm.ac.id
ORCID: 0000-0001-5011-0695

Abdullah
English Department, Doctoral Program
Universitas Negeri Makassar
Indonesia
abdullah5891@.unm.ac.id
ORCID: 0009-0007-1626-4464

Suci Pole Mappaita
Faculty of Language and Literature
Universitas Negeri Makassar
Indonesia
suci.pole.mappaita@.unm.ac.id
ORCID: 0009-0006-4142-9702