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PHYSICS AND MATHEMATICS STUDENTS' PERSPECTIVES ON THE USE OF AI-CALI IN ENGLISH LEARNING

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Abstract

This study examines physics and mathematics education students' feedback on the implementation of AI enhanced Computer Assisted Language Instruction in learning English. As AI becomes increasingly integrated into higher education, understanding students' experiences in using AI supported language learning within discipline specific contexts is essential for effective pedagogical development. This study employed a qualitative descriptive design involving twenty undergraduate students comprising ten physics education students and ten mathematics education students at STKIP DDI Pinrang. Data were collected through semi structured interviews and analyzed using thematic analysis. The findings indicate that students generally have positive perceptions of AI enhanced CALI in English learning. They value personalized feedback, accessibility, support for vocabulary development and basic grammar. Several limitations were identified, particularly in the ability of AI to explain discipline specific concepts and support advanced academic writing and scientific communication. Differences in responses were influenced by students' English proficiency levels and familiarity with digital technology. This study concludes that AI enhanced CALI has strong potential to improve English for Sciences instruction when supported by appropriate pedagogical strategies and human interaction. The findings contribute to the development of technology integrated ESP learning and provide insights for optimizing AI use in higher education contexts.

Keywords: *AI enhanced CALI, Artificial Intelligence in education, ESP learning, higher education, student feedback*

INTRODUCTION

The rapid advancement of artificial intelligence (AI) has transformed various educational practices, including language learning. In the context of English as a Foreign Language (EFL) education, AI-powered tools such as ChatGPT, Grammarly, and Duolingo have gained increasing attention for their potential to enhance learner autonomy, provide instant feedback, and personalize the learning process (Zawacki-Richter et al., 2019; Li et al., 2023). These technologies offer unprecedented opportunities to address longstanding challenges in language education, particularly in contexts where access to native speakers and authentic language resources is limited. The integration of AI tools enables students to engage with English beyond traditional classroom hours, receiving immediate corrective feedback and accessing tailored learning materials that correspond to their proficiency levels and learning pace (Luckin et al., 2016).

The integration of these technologies in higher education is particularly relevant for non-English major students who require English not only for general communication but also for specific disciplinary purposes. Unlike English major students who focus extensively on language acquisition as their primary academic goal, non-English majors encounter English as a supplementary yet critical competency for accessing disciplinary knowledge, understanding international research, and participating in global academic discourse (Hyland, 2006). This dual requirement mastering both their core discipline and developing sufficient English proficiency presents unique pedagogical challenges that necessitate innovative instructional approaches.

In Indonesia, English for Specific Purposes (ESP) courses are essential components of tertiary education, including programs in physics and mathematics education. These students are expected to comprehend scientific texts, produce academic writing, and engage in professional communication within the STEM domain (Hutchinson & Waters, 1987; Sardi et al, 2026). The demands placed on these students extend beyond basic English proficiency to include specialized vocabulary, genre-specific writing conventions, and the ability to interpret complex technical literature (Basturkmen, 2010). However, ESP instruction in Indonesian higher education often faces significant constraints, including limited contact hours, large class sizes, heterogeneous proficiency levels, and insufficient materials specifically designed for STEM disciplines (Lengkanawati, 2005; Marcellino, 2008). These institutional challenges frequently result in instruction that inadequately addresses the specialized language needs of science and mathematics students.

At STKIP DDI Pinrang, a teacher training institution in South Sulawesi, these challenges manifest distinctly among physics and mathematics education students. Preliminary observations conducted by the researcher revealed a concerning pattern of low motivation and limited engagement with English learning among these student populations. Many students demonstrated reluctance to participate actively in English classes, expressing feelings of inadequacy and perceiving English as disconnected from their primary academic and professional interests. This lack of interest was particularly evident in their minimal engagement with course materials, passive participation during classroom activities, and limited effort in completing English assignments. The students' attitudes reflected a common perception among STEM learners that English constitutes an obligatory but peripheral component of their education rather than an integral tool for their disciplinary development (Flowerdew & Peacock, 2001).

However, a notable shift in student engagement emerged following an initial intervention by the researcher. During preliminary classroom sessions, the researcher introduced several AI-powered tools specifically designed to support English learning within their disciplinary contexts. These included ChatGPT for generating and refining scientific explanations, Grammarly for improving academic writing, QuillBot for paraphrasing complex texts, and discipline-specific AI applications capable of simplifying technical English content. The introduction of these tools was accompanied by guided demonstrations showing how AI could assist students in understanding physics and mathematics literature in English, drafting laboratory reports, and preparing teaching materials in English for their future professional roles as educators.

The response to these AI tools was remarkably positive. Students who had previously shown minimal interest in English learning demonstrated heightened curiosity and willingness to engage with language learning tasks when mediated through AI technologies. They expressed particular enthusiasm about the immediate feedback mechanisms, the ability to work independently at their own pace, and the practical applicability of these tools to their discipline-specific needs. This preliminary observation suggested that AI integration might offer a viable pathway to address the motivational challenges that have historically characterized English learning among non-English majors in this institutional context.

Despite the increasing adoption of AI tools in language education globally, and the promising initial response observed at STKIP DDI Pinrang, little is known about how students in physics and mathematics education fields systematically perceive and experience AI-assisted English learning. Existing research on AI in language education has predominantly focused on general English contexts or has been conducted in educational settings markedly different from Indonesian provincial institutions (Bin Dahmash, 2020; Chiu et al., 2023). Furthermore, there remains a significant gap in understanding how students from STEM backgrounds who approach language learning with distinct needs, expectations, and initial attitudes navigate the integration of AI technologies into their English learning processes.

Therefore, this study aims to explore the feedback of physics and mathematics education students at STKIP DDI Pinrang on the use of AI in English learning. Specifically, the research investigates students' perceptions of AI tools' effectiveness, their experiences in using these technologies for discipline-specific English tasks, the challenges they encounter, and their preferences regarding AI integration in ESP instruction. Understanding their experiences, concerns, and suggestions provides valuable insights into how AI can be effectively integrated into discipline-specific English instruction, particularly in resource-constrained institutional contexts where traditional pedagogical approaches have proven insufficient to motivate and engage STEM learners with English language development. Hence, the research questions formulated are how physics and mathematics education students perceive the use of AI in English learning and what benefits and challenges that they experience when using AI tools for learning English.

AI-CALI in English Language Learning

Artificial intelligence has fundamentally redefined language education by enabling adaptive learning systems, automated feedback mechanisms, and interactive communication platforms that were previously unattainable through traditional instructional methods (Fitria, 2023; Sardi et al, 2026). The integration of AI technologies into language learning represents a paradigm shift from one-size-fits-all instruction to highly personalized, learner-centered approaches that can accommodate individual differences in learning pace, style, and proficiency level. AI-based platforms leverage sophisticated algorithms, including machine learning and natural language processing, to analyze learners' performance in real time, offering personalized recommendations, immediate corrections, and tailored learning pathways that respond dynamically to student needs (Bai & Guo, 2021).

These intelligent systems support multiple dimensions of language acquisition, including vocabulary building through spaced repetition algorithms, grammar correction with contextual explanations, pronunciation improvement via speech recognition technology, and writing enhancement through automated essay scoring and feedback generation (Burstein et al., 2018). Popular AI applications such as Duolingo employ gamification strategies combined with adaptive algorithms to maintain learner motivation, while tools like Grammarly provide instant, context-sensitive feedback on written English that helps students identify and correct errors independently (Koltovskaia, 2020). ChatGPT and similar large language models have introduced conversational AI capabilities that allow students to engage in authentic-like dialogues, receive explanations in simplified language, and practice communication skills without the anxiety often associated with human interaction (Rudolph et al., 2023).

The pedagogical advantages of AI integration extend beyond mere automation of traditional tasks. Research indicates that AI tools contribute significantly to learner autonomy by enabling self-directed learning outside formal classroom settings, thereby extending learning opportunities and fostering independent study habits (Zou et al., 2023). Furthermore, the immediate feedback provided by AI systems addresses a critical limitation of conventional instruction, where delayed teacher feedback can reduce the effectiveness of error correction and hinder timely learning reinforcement (Shintani, 2016). The scalability of AI solutions also presents opportunities to address resource constraints in educational contexts where high student-to-teacher ratios limit individualized attention.

However, the implementation of AI in language education is not without complexity. Concerns have been raised regarding the pedagogical soundness of purely algorithmic approaches, the potential for over-reliance on technology at the expense of human interaction, and questions about whether AI feedback truly promotes deep learning or merely surface-level corrections (Warschauer et al., 2021). Additionally, issues of digital equity, data privacy, and the cultural appropriateness of predominantly Western-developed AI systems in diverse educational contexts remain subjects of ongoing scholarly debate.

English for STEM and EFS Students

Students in science, technology, engineering, and mathematics (STEM) and English for sciences (EFS) disciplines require English proficiency not merely as a general communication skill but as a fundamental tool for accessing, producing, and disseminating disciplinary knowledge in an increasingly globalized academic and professional environment (Flowerdew & Peacock, 2001). The role of English in STEM fields has become particularly critical as English has solidified its position as the lingua franca of international scientific discourse, with the vast majority of high-impact research publications, conference proceedings, and technical documentation produced in English (Lillis & Curry, 2010).

English learning in STEM contexts focuses on several specialized competencies that extend beyond general language proficiency. Students must acquire technical vocabulary specific to their disciplines, which often includes Greco-Latin terminology, specialized collocations, and field-specific acronyms that rarely appear in everyday English usage (Nation, 2013). For physics students, this encompasses terms related to mechanics, thermodynamics, quantum phenomena, and mathematical representations of physical laws. Mathematics education students similarly encounter specialized lexicon including geometric terminology, algebraic expressions, statistical concepts, and pedagogical vocabulary necessary for teaching mathematics in English or accessing international mathematics education research.

Beyond vocabulary acquisition, STEM or EFS students must master academic writing conventions that govern scientific communication, including the structural organization of research articles (IMRD format), the use of hedging language to express appropriate epistemic stance, the integration of visual elements such as graphs and equations into written text, and the conventions of citation and referencing in scientific writing (Hyland, 2009). The ability to comprehend complex syntactic structures common in scientific prose including dense noun phrases, passive constructions, and embedded clauses is essential for reading comprehension of research literature (Biber & Gray, 2016).

Furthermore, STEM students require proficiency in specific communicative genres beyond traditional academic writing. These include laboratory report writing with its distinctive structure and style, the preparation of scientific presentations with appropriate visual support, the formulation of research proposals and grant applications, and increasingly, the production of science communication materials that translate specialized knowledge for broader audiences (Swales & Feak, 2012; Sardi et al, 2026). For future educators in physics and mathematics, an additional layer of English proficiency involves pedagogical discourse; the language used to explain, question, and facilitate learning of STEM concepts in educational settings.

Despite the critical importance of English for Science students or STEM students, ESP instruction in these disciplines faces persistent challenges. Many STEM students enter ESP courses with relatively low English proficiency and limited motivation, viewing English as peripheral to their core disciplinary studies (Arnó-Macià & Mancho-Barés, 2015). Traditional ESP materials often fail to authentically represent the language practices of their target disciplines or inadequately address the multimodal nature of scientific communication (Hafner & Miller, 2011). Additionally, ESP instructors, frequently lacking deep STEM content knowledge, may struggle to provide discipline-appropriate language instruction, while disciplinary faculty, despite their content expertise, typically lack pedagogical training in language instruction (Lear & Li, 2009).

The integration of AI-CALI tools in ESP for EFS/STEM presents both opportunities and challenges. While AI systems excel at providing general language support, they may struggle to capture the nuances of discipline-specific communication, including the appropriate use of technical terminology in context, the rhetorical conventions specific to scientific genres, and the epistemological values embedded in disciplinary discourse practices (Lee, 2020). Questions remain about whether general-purpose AI tools can adequately support the highly specialized language needs of STEM students or whether discipline-specific AI applications are necessary.

Previous Studies on Student Perception of AI

The literature examining student perceptions of AI in language learning reveals a complex landscape of attitudes, beliefs, and experiences that reflect both the transformative potential and inherent limitations of these technologies. Prior research consistently demonstrates that students often perceive AI as a valuable supplementary tool that enhances their learning experience rather than as a complete replacement for human instruction (Godwin-Jones, 2021). This perception reflects a pragmatic understanding among learners that while AI offers certain advantages, particularly in providing immediate feedback and enabling independent practice, it cannot fully replicate the pedagogical expertise, emotional intelligence, and adaptive responsiveness of human teachers.

Studies examining learner attitudes toward specific AI tools have yielded nuanced findings. Research by Jiang et al. (2022) investigating Chinese university students' use of AI writing assistants found that while learners appreciated the immediacy and technical accuracy of AI feedback on grammatical errors and stylistic issues, they expressed reservations about the tools' ability to understand their intended meaning, recognize culturally specific references, or provide feedback that promoted critical thinking about their writing choices. Students reported that AI feedback sometimes felt mechanical and failed to address higher-order concerns related to argumentation, organization, and audience awareness that they valued in teacher feedback.

Similarly, Rahman and Wibowo (2024) in their study of Indonesian EFL learners' perceptions of ChatGPT revealed mixed attitudes characterized by enthusiasm about the tool's accessibility and responsiveness alongside concerns about context insensitivity and the potential for over-reliance. Students valued ChatGPT's ability to explain grammatical concepts, provide vocabulary definitions, and generate example sentences, but expressed uncertainty about the accuracy of its responses, particularly regarding idiomatic expressions and culturally specific language use. Some participants worried that dependence on AI might undermine their development of independent language processing skills and critical evaluation abilities.

Research focusing on student perceptions of AI-powered language learning applications like Duolingo has highlighted motivational benefits alongside pedagogical concerns. Studies indicate that students appreciate gamification elements, progress tracking, and the low-stakes environment that reduces language anxiety (Munday, 2016). However, critics note that students also recognize limitations in these applications' ability to develop communicative competence, pragmatic awareness, and the spontaneous language production required for authentic interaction (Loewen et al., 2019).

The disciplinary context significantly influences student perceptions of AI tools. Limited research specifically examining STEM students' attitudes toward AI for English learning suggests that these learners may hold distinct perspectives shaped by their analytical mindset, comfort with technology, and pragmatic orientation toward language learning as a means to disciplinary ends rather than an end in itself (Tsai & Tsai, 2020). STEM students may be particularly attuned to issues of accuracy, efficiency, and practical utility when evaluating AI tools, but potentially less concerned with the sociolinguistic and intercultural dimensions of language learning that humanities students might prioritize.

Concerns raised across multiple studies include issues of data privacy, with students expressing uncertainty about how their language data is collected, stored, and potentially used by AI platforms (Bin Dahmash, 2020). Academic integrity concerns have also emerged, particularly regarding the use of AI-generated text in assessed writing tasks and the challenge of distinguishing between AI-assisted learning and academic misconduct (Sullivan et al., 2023). Additionally, students from diverse linguistic and cultural backgrounds have noted that many AI tools reflect Western, particularly American, varieties of English and may inadequately represent the linguistic diversity of global English use (Kukulska-Hulme et al., 2021).

These mixed perceptions and context-dependent attitudes highlight the critical importance of investigating student feedback within specific academic domains, institutional contexts, and cultural settings. The experiences of physics and mathematics education students at a provincial Indonesian teacher training institution with their unique combination of disciplinary focus, institutional resources, cultural context, and educational objectives may differ substantially from those reported in existing literature, which has predominantly focused on general English contexts in well-resourced urban universities. Understanding these discipline-specific and context-specific perceptions is essential for developing pedagogically sound, contextually appropriate approaches to AI integration in ESP instruction.

METHOD

Research Design

This study employed a qualitative descriptive design to explore students' feedback on AI-assisted English learning. Qualitative descriptive research is particularly suited for investigations seeking to understand phenomena from participants' perspectives without imposing predetermined theoretical frameworks or attempting to generate theory (Sandelowski, 2000). This methodological approach enables researchers to stay close to the data and provide rich, straight descriptions of participants' experiences as they naturally occur in their contexts (Colorafi & Evans, 2016). The choice of this design reflects the study's exploratory nature and its commitment to capturing the authentic voices and nuanced experiences of physics and mathematics education students as they navigate AI-integrated English learning at STKIP DDI Pinrang.

The descriptive qualitative approach offers several advantages for this investigation. It allows for comprehensive examination of complex, context-dependent phenomena without reducing them to measurable variables, thereby preserving the richness and complexity of student experiences (Neergaard et al., 2009). Additionally, this design accommodates the study's aim to generate practical insights directly applicable to pedagogical practice rather than to develop abstract theoretical propositions. The flexibility inherent in descriptive qualitative research permits researchers to follow emerging lines of inquiry during data collection while maintaining systematic rigor in analysis (Kim et al., 2017).

Research Participants

The participants consisted of twenty undergraduate students enrolled in physics and mathematics education programs at STKIP DDI Pinrang, South Sulawesi, Indonesia. Ten students were recruited from the physics education department and ten from the mathematics education department, ensuring balanced representation from both disciplinary contexts. The selection of these two departments reflects the study's focus on STEM education students who share similar pedagogical purposes preparing to become secondary school science and mathematics teachers while potentially demonstrating distinct disciplinary approaches to English language learning.

Participants were selected using purposive sampling, a non-probability sampling technique appropriate for qualitative research seeking information-rich cases that can provide in-depth insights into the phenomenon under investigation (Palinkas et al., 2015). The sampling strategy aimed to ensure diversity across several key characteristics: gender representation (with approximately equal numbers of male and female participants), academic year distribution (including students from second through fourth years to capture varying levels of ESP course exposure), and AI usage experience (encompassing both frequent and occasional users to represent different engagement levels with AI tools). All participants had been exposed to AI tools for English learning through the researcher's preliminary intervention sessions and had sufficient experience to provide meaningful feedback on their use.

Participant recruitment involved initial announcements during ESP classes, followed by individual invitations to students who met the sampling criteria and expressed willingness to participate. All participants provided informed consent after receiving detailed explanations about the study's purpose, procedures, voluntary nature of participation, confidentiality protections, and their right to withdraw at any time without consequences. Ethical clearance for the study was obtained from the institutional research ethics committee at STKIP DDI Pinrang.

Data Collection

Data were gathered through semi-structured interviews, a method that combines predetermined questions ensuring systematic coverage of key topics with flexibility to explore emergent themes and follow participants' unique perspectives (Kallio et al., 2016). The interview protocol was developed based on the research questions and included open-ended questions organized around four main themes: (1) general perceptions and attitudes toward AI in English learning, (2) specific experiences using AI tools for disciplinary English tasks, (3) perceived benefits and affordances of AI-assisted learning, and (4) challenges, limitations, and concerns encountered when using AI tools. Follow-up probes were used strategically to encourage elaboration, clarification, and concrete examples from participants' experiences.

Interviews were conducted individually in a quiet, private setting on campus to ensure comfort and minimize distractions. Each interview lasted approximately 30 to 45 minutes, with duration varying based on participants' elaborateness and the depth of discussion. Recognizing participants' varying English proficiency levels and to ensure authentic expression of their experiences, interviews were conducted in a flexible bilingual format, allowing participants to use either English or Indonesian (Bahasa Indonesia) as they felt comfortable. This linguistic accommodation prevented language barriers from constraining participants' ability to articulate nuanced perceptions and experiences, thereby enhancing data quality and trustworthiness (Temple & Young, 2004).

All interviews were audio-recorded with participants' permission to ensure accurate capture of their responses. Field notes were maintained throughout data collection to document contextual information, non-verbal cues, initial impressions, and emerging patterns that might inform subsequent interviews and analysis. Following each interview, audio recordings were transcribed verbatim, with Indonesian responses translated into English by the researcher, who is fluent in both languages. To ensure translation accuracy and preserve meaning, back-translation procedures were employed for selected excerpts, and a bilingual colleague reviewed translated segments for consistency.

Data Analysis

The interview data were analyzed using thematic analysis, a systematic method for identifying, analyzing, and reporting patterns of meaning (themes) within qualitative data (Braun & Clarke, 2006). Thematic analysis was selected for its theoretical flexibility, accessibility for novice qualitative researchers, and capacity to generate rich, detailed accounts of complex phenomena while remaining manageable in scope (Braun et al., 2019). The analysis followed Braun and Clarke's (2006) six-phase recursive process, which, while presented sequentially, involved iterative movement between phases as understanding deepened.

The first phase, familiarization with the data, involved repeated reading of the complete dataset to achieve immersion and develop intimate knowledge of the data's depth and breadth. During this phase, the researcher read through all transcripts multiple times while listening to corresponding audio recordings to recapture participants' tone and emphasis. Initial observations and potential patterns of interest were noted in a reflective journal, establishing preliminary familiarity that would inform subsequent coding.

The second phase, generating initial codes, involved systematic examination of the entire dataset to identify features of interest relevant to the research questions. Codes represent the most basic meaningful units of analysis—features that appear interesting or significant for understanding participants' experiences with AI in English learning. This coding process was conducted manually, with codes written directly on printed transcripts and compiled in a separate coding document organized by participant. The researcher employed both semantic codes (identifying explicit surface meanings) and latent codes (capturing underlying ideas and assumptions) to capture multiple layers of meaning in the data. Attention was given to ensuring that codes remained close to participants' language while beginning the process of analytical interpretation.

The third phase, searching for themes, involved examining codes to identify broader patterns of meaning and collating codes into potential themes. A theme captures something significant about the data in relation to the research questions and represents a level of patterned meaning beyond individual codes (Braun & Clarke, 2006). Codes were grouped into preliminary themes based on shared underlying meanings, with visual mapping techniques (such as mind maps and tables) used to organize codes and explore relationships between them. This phase marked the shift from codes to themes, requiring more interpretive analytical work to determine what the patterns meant in relation to the research questions.

The fourth phase, reviewing themes, involved iterative refinement of the preliminary theme structure. This occurred at two levels: first, reviewing coded data extracts within each theme to ensure internal homogeneity (that data within themes cohere meaningfully) and external heterogeneity (that clear distinctions exist between themes); and second, reviewing the entire dataset to ensure the theme structure accurately reflects the meanings evident across the complete data corpus. Some themes were collapsed into each other, others were broken into separate themes, and some were discarded as they lacked sufficient data support. This phase concluded with a coherent pattern of themes that told a convincing story about the data.

The fifth phase, defining and naming themes, involved detailed analysis of each theme to determine its essence and scope. For each theme, the researcher developed clear definitions specifying what the theme captures and its boundaries, ensuring themes were not too diverse or complex. Subthemes were identified where appropriate to provide structure within themes and capture important nuances. Theme names were crafted to be concise yet informative, immediately conveying the theme's content to readers. This phase produced a comprehensive thematic map with clearly defined themes and subthemes supported by illustrative data extracts.

The final phase, producing the report, involved weaving together the analytical narrative with vivid, compelling data extracts to tell the coherent story of the data that addresses the research questions. The selection of extracts aimed to demonstrate the prevalence and meaning of each theme while giving voice to participants' authentic experiences. The analysis moves beyond description to make arguments about how themes relate to existing literature and what they reveal about physics and mathematics education students' experiences with AI in English learning.

Throughout the analysis process, several strategies enhanced rigor and trustworthiness. The researcher maintained a reflexive journal documenting analytical decisions, assumptions, and evolving interpretations. Peer debriefing sessions with colleagues provided opportunities to discuss emerging themes and alternative interpretations, challenging the researcher's assumptions and enriching analysis. Additionally, attention to negative cases—instances that did not fit emerging patterns ensured themes adequately captured data complexity rather than oversimplifying participants' diverse experiences. While member checking (returning findings to participants for validation) was considered, the pragmatic constraints of the institutional context limited its implementation. However, the rich description and extensive use of direct quotations in reporting enable readers to assess the credibility and transferability of findings.

FINDINGS AND DISCUSSIONS

Positive Attitudes toward AI-CALI Integration

Most participants demonstrated a strong sense of enthusiasm toward the integration of AI-CALI tools in English learning. Out of twenty students, sixteen described AI as "helpful" and "motivating," while twelve specifically mentioned that it made English learning "more enjoyable and less stressful." One mathematics education student stated:

"Using ChatGPT makes me more confident because I can ask many questions without feeling embarrassed. It's like having a patient teacher who never gets tired." (Student 1)

These responses indicate that AI's interactive nature contributes to reducing learning anxiety and fostering learner autonomy. This aligns with Li et al. (2023), who argue that AI systems enhance student engagement through adaptive interaction and immediate response mechanisms. Similarly, Godwin-Jones (2021) emphasizes that the conversational interface of AI tools can simulate authentic communication, providing learners with a safe and supportive environment to practice English.

Furthermore, AI's flexibility and accessibility were appreciated by students in rural settings. Several participants noted that they could access AI anytime without relying on institutional schedules, reflecting the growing trend of ubiquitous learning supported by mobile and AI technologies (Zawacki-Richter et al., 2019). Hence, students' positive attitudes reveal the potential of AI to democratize English education by offering individualized and on-demand learning experiences.

Personalized Learning and Motivation

A recurring theme among participants was AI's ability to deliver personalized feedback. Eighteen students reported that AI systems, such as ChatGPT and Grammarly, effectively identified their writing errors and offered contextual corrections. One physics student commented:

"I can immediately see what mistakes I make. Grammarly even explains why the grammar is wrong and suggests better words." (Student 2)

This finding corroborates Bai and Guo (2021), who highlight AI's data-driven feedback mechanism as a factor enhancing learner self-regulation. Participants expressed that the individualized suggestions helped them track their progress, increasing their sense of ownership in learning.

In addition, AI use appeared to boost motivation and confidence. Students appreciated AI's non-judgmental feedback, which differs from traditional classroom correction that may cause embarrassment. According to Dörnyei's (2005) motivational framework, positive feedback and learner autonomy are key components sustaining long-term motivation both of which were evident in participants' narratives. However, a few participants mentioned that AI sometimes provided overly generic feedback, indicating a need for contextual adaptation. This suggests that personalization in AI still requires refinement to address discipline-specific learning objectives.

Challenges in Discipline-Specific Contexts

Despite their general satisfaction, students recognized AI's limitations in handling subject-specific language, especially in explaining terms rooted in physics and mathematics. Ten participants explicitly noted that AI explanations often lacked disciplinary precision. For example:

"When I ask about terms like 'wave interference,' it gives general answers without connecting to real physics concepts." (Student 18)

"AI sometimes translates math terms wrongly. For example, it confuses 'function' as a role, not a mathematical function." (Student 9)

These excerpts reveal the tension between general-purpose AI language models and the specialized linguistic demands of ESP (English for Specific Purposes) contexts. Hutchinson and Waters (1987) argue that ESP learners require content tailored to their field, emphasizing situational and disciplinary relevance.

The findings support Jiang et al. (2022), who observed that AI-powered tools are often trained on generic linguistic data, limiting their ability to provide context-aware feedback in academic or scientific English. Hence, while AI tools aid general comprehension, they are not yet optimized for disciplinary literacy in STEM fields. This underscores the need for localized AI systems trained on domain-specific corpora.

Limited Role in Academic Writing

Although AI tools enhanced surface-level language accuracy, students found them less capable of improving academic writing quality. Thirteen participants admitted relying on AI for grammar checks and paraphrasing, but they felt it could not guide them in organizing arguments, maintaining cohesion, or using formal academic style. One mathematics education student explained:

"AI can fix my grammar, but it doesn't teach me how to write a good introduction or connect ideas logically." (Student 6)

This observation aligns with Rahman and Wibowo (2024), who reported that AI excels in form-level corrections but struggles to scaffold higher-order writing skills such as argumentation and synthesis. Students also recognized the value of human feedback from lecturers to complement AI suggestions, a reflection of what Warschauer (2023) terms the "hybrid pedagogy" model, combining AI efficiency with human judgment. In line with Hyland's (2019) theory of academic discourse, the lack of contextual sensitivity in AI outputs may prevent students from developing a full understanding of disciplinary writing conventions. Therefore, educators should guide students in critically evaluating AI-generated feedback rather than accepting it uncritically.

Variations Based on English Proficiency

Analysis revealed distinct patterns between students of different English proficiency levels. High-proficiency students (n=8) used AI strategically primarily for text revision, idea generation, and vocabulary refinement. They reported that AI helped them "expand academic vocabulary" and "enhance lexical variety." Conversely, low-proficiency students (n=12) tended to use AI for translation and direct answers, sometimes copying responses without comprehension. One participant admitted:

"Sometimes I just copy ChatGPT's answer to my assignment because it's easier and correct." (Student 15)

This finding raises concerns about AI overdependence, echoing Li et al. (2023), who warn that excessive reliance on automated systems may hinder critical thinking and language autonomy. As Kim (2024) suggests, teachers need to design learning tasks that encourage reflective use of

AI, ensuring that students engage cognitively with the feedback. The variation also supports Dörnyei and Ryan's (2015) view that learner differences including proficiency and self-efficacy, shape how technological affordances are perceived and utilized. Thus, pedagogical strategies must account for these differences to ensure equitable learning outcomes across proficiency levels.

Overall, the study found that AI-assisted English learning fosters motivation, accessibility, and personalized learning, yet presents challenges in disciplinary relevance and critical literacy development. The evidence suggests that while AI tools can complement English learning, they should not replace traditional instruction, particularly in academic writing and ESP contexts. Integrating AI into a blended, reflective pedagogy may provide the most balanced approach for physics and mathematics education students.

CONCLUSION

This study explored physics and mathematics education students' feedback on the implementation of AI enhanced Computer Assisted Language Instruction (AI CALI) in teaching English for Sciences within an English for Specific Purposes context. The findings demonstrate that AI CALI plays a significant supportive role in facilitating language learning, particularly in improving vocabulary acquisition, grammar accuracy, and learner motivation. Students highly valued features such as immediate feedback, personalized support, and flexible access, which contributed to increased autonomy and engagement in the learning process. These results indicate that AI CALI has strong potential to enhance accessibility and effectiveness in English learning for students in scientific disciplines.

However, the study also identifies important limitations in the use of AI CALI, particularly in addressing discipline specific language needs and higher-level academic skills. Students reported that AI tools often lack the ability to provide accurate and in-depth explanations of scientific concepts, which are essential in physics and mathematics communication. While AI CALI effectively supports basic language skills, it remains insufficient for developing advanced competencies such as academic writing, critical reasoning, and scientific discourse. This suggests that AI based learning tools must be complemented by human interaction and pedagogical guidance to ensure meaningful learning outcomes.

Therefore, this study concludes that AI CALI should be implemented as a complementary component within a blended learning framework rather than as a substitute for lecturers. The integration of AI supported tools with teacher guided instruction can optimize both efficiency and depth in English for Sciences learning. These findings provide important implications for educators, curriculum developers, and institutions to design context sensitive, AI integrated ESP learning models that align with the linguistic and disciplinary demands of higher education.

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