

CHAPTER 9. ACTIVATING STUDENTS' COGNITIVE ENGAGEMENT IN TECHNICAL ENGLISH LEARNING WITH AI TOOLS

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Abstract. The ongoing russian-Ukrainian war has posed unprecedented challenges to Ukraine's education system, particularly in technical universities where the demand for English language competence remains high despite infrastructure disruptions, displacement, and psychological stress. In this context, the development of students' critical thinking and cognitive engagement has become both a pedagogical necessity and a form of intellectual resilience. This chapter investigates the integration of Artificial Intelligence tools – specifically ChatGPT, Grammarly, and Quillionz – into technical English instruction as a means of fostering higher-order thinking skills. While global research highlights the potential of AI to enhance learning, most studies overlook war-affected environments and discipline-specific needs of technical learners. Through a theoretically grounded and practice-oriented analysis, this work demonstrates how AI tools can serve not as replacements for educators, but as cognitive scaffolds that support reflective writing, dialogic reasoning, and inquiry-based reading. The findings reveal that when used under guided conditions, these tools encourage metacognitive awareness, deepen conceptual understanding, and simulate professional communication tasks. However, the study also cautions against uncritical use, pointing to the risk of cognitive passivity and overreliance in the absence of pedagogical framing. Drawing analogies with Ukraine's broader struggle for independence and agency, the chapter positions AI-assisted learning as a form of educational resistance – one that equips students with the intellectual tools to think independently and act purposefully. The chapter concludes by outlining key strategies for integrating AI into curricula responsibly and calls for further research on long-term impacts, especially in the post-war recovery phase.

Keywords: critical thinking, cognitive engagement, technical English, artificial intelligence (AI), ChatGPT, Grammarly, Quillionz.

Introduction. In the face of rapid technological evolution and shifting educational paradigms, the teaching of English for Specific Purposes (ESP) – particularly in technical contexts – has acquired new dimensions. While the mastery of terminology, syntax, and discourse conventions remains foundational, contemporary instruction increasingly demands that students develop higher-order cognitive skills, such as critical thinking, analytical reasoning, and metacognitive awareness. These competencies are not only instrumental for academic success, but also essential for navigating complex communicative tasks in the globalised and digitised workplace (*Halpern, 2014*). For Ukrainian technical universities, which are currently undergoing profound transformations due to both internal reform and the external pressures of wartime resilience, the integration of innovative technologies into the language classroom offers new pathways for activating students' cognitive engagement and promoting linguistic autonomy.

Cognitive engagement – understood as the depth of processing with which students approach learning tasks – is a multidimensional construct. It encompasses not only sustained attention and effort, but also the use of sophisticated learning strategies, the ability to monitor one's own understanding, and the motivation to apply knowledge flexibly across contexts (*Fredricks, Blumenfeld & Paris, 2004*). In the context of technical English, such engagement becomes particularly crucial, given the abstract and often specialised nature of the subject matter. Students are expected to interpret technical documentation, participate in professional discourse, and engage with domain-specific problems, all of which demand more than surface-level language competence. Hence, fostering active cognitive engagement is a central concern for language educators in technical institutions.

Recent developments in Artificial Intelligence (AI) present both opportunities and challenges in this regard. With the rise of generative language models, intelligent writing assistants, and AI-powered content creation tools, educators now have access

to a wide range of digital instruments that can scaffold, personalise, and enrich the learning experience. Tools such as ChatGPT, Grammarly, and Quillionz, for example, provide real-time feedback, generate questions, reformulate student input, and even simulate dialogues – all of which can be used to stimulate active processing and reflective thinking. When applied strategically, such tools can serve as cognitive amplifiers, encouraging students to interrogate their own reasoning, refine their output, and approach language not as a static body of rules, but as a dynamic vehicle for meaning-making (*Luckin, Holmes, Griffiths & Forcier, 2016*).

Nevertheless, the pedagogical use of AI in language education must be approached with both curiosity and caution. While it is tempting to view these tools as panaceas, their effectiveness depends largely on the instructional context, the learner profile, and the way they are embedded into the curriculum. Ukrainian educators, in particular, must navigate a complex intersection of limited resources, varying levels of digital literacy, and the need to uphold academic integrity amid a growing dependence on algorithmic content generation. Moreover, there remains the risk that students may come to rely on these technologies uncritically, outsourcing their cognitive effort rather than developing it. Thus, the challenge lies not merely in introducing AI into the classroom, but in doing so in a way that genuinely fosters engagement, reflection, and intellectual growth.

This chapter explores the potential of selected AI tools to activate cognitive engagement in the process of learning technical English. Drawing on both theoretical perspectives and classroom-based observations, it analyses how ChatGPT, Grammarly, and Quillionz can be integrated into ESP instruction to enhance critical thinking, metacognitive regulation, and content-specific communication. The analysis is grounded in the Ukrainian higher education context, which presents both particular constraints and unique affordances for technology-enhanced language learning. In doing so, this chapter aims to contribute to a broader conversation about the future of English language teaching in technical settings – one that is not only technologically informed, but also pedagogically principled and responsive to the evolving needs of learners.

Theoretical foundations. In contemporary higher education – and particularly within the context of technical universities – the teaching of English is no longer confined to grammar drills, vocabulary acquisition, and rote memorisation of phrases. The demands placed on future engineers, IT specialists, and technical professionals extend well beyond basic communicative competence. These graduates are expected to operate confidently in multilingual and multicultural environments, to interpret and produce a wide range of specialised texts, and to contribute meaningfully to professional dialogues within their domains. In this light, English functions not only as a lingua franca of global communication, but also as a key to accessing and generating disciplinary knowledge. Its role within technical education is thus both instrumental and epistemic: it enables students not only to interact but also to think, problem-solve, and innovate within their fields.

Zakaria, Hashim & Jamaludin (2025) conducted a meta-analysis of 51 quasi-experimental studies (Nov 2022-Feb 2025) examining ChatGPT's effects on learning performance, perceptions, and higher-order thinking. Their results (Zakaria, 2025) reveal a large positive effect on performance ($g = 0.867$) and a moderate effect on perception and higher – order thinking (both $\sim g = 0.457$).

Notably, they highlight the critical need for pedagogical scaffolding aligned with frameworks like Bloom's taxonomy to harness ChatGPT effectively. However, despite the general positivity, variation across disciplines and implementation duration indicates that cause – effect relationships remain underexplored – for example, the ideal duration of tool use remains unclear. Hence, contextualised studies (e.g. within technical English at Ukrainian institutions) are still needed.

Benítez (2024) explored ChatGPT-enhanced debate sessions among 95 undergraduates in international relations, showing significant improvements in argumentation and critical thinking compared to traditional methods. While the context differs from technical English, the study validates ChatGPT's potential in structured discourse. Importantly, it notes limitations in infrastructure and language proficiency – an issue also relevant in war-affected Ukrainian technical universities.

A preprint MIT study (*Bangerl et al., 2025*) examined cognitive outcomes for students writing SAT-style essays using ChatGPT, Google, or unaided. They found that ChatGPT users exhibited reduced neural activity, diminished creativity, and “metacognitive laziness” over repeated sessions. These sobering results underscore the risk of cognitive offloading, making it imperative to frame AI within guided and reflective learning practices.

Recent systematic reviews in ESL and ESP contexts (*Ziar, 2025*) echo positive and negative consequences: AI tools enhance writing quality and support critical thinking, but excessive reliance may hinder independence. The consistency across these analyses strengthens the notion that AI must be embedded with pedagogical intent. Research in technical ESP remains sparse – even as general findings are promising, they are not yet tailored to the specific genres present in engineering or applied sciences.

Singh et al. (2025) designed metacognitive prompts to guide users in critically evaluating AI-generated search responses. Their study showed that prompts increased reflection, multi-perspective thinking, and follow-up inquiry actions. Such research highlights a novel direction: AI-aware scaffolding, which could be adapted for technical English tasks (e.g., assessing technical explanations via AI).

Yuan (2024) investigated generative AI’s capacity to facilitate reflective learning via dialogic prompts. Their findings show that well-designed prompts can simulate tutor-like reflection at scale. This approach is particularly relevant in displaced settings where teacher access is inconsistent – a scenario shared by many Ukrainian learners.

Table 1.

Identified gaps and novelty of current study

Gap	Research opportunity
Contextual specificity	Most existing studies address generic ESL or academic writing; technical English in STEM domains remains under-researched
Pedagogical scaffolding	Few studies test explicit frameworks (e.g. Bloom, Paul-Elder) within AI-integrated ESP courses
War-disrupted environments	Ukrainian contexts – characterised by reliability issues and psychosocial stress – are not represented in the literature
Integrated multimodal tool analysis	Past work tends to focus on single tools; comprehensive comparative studies (ChatGPT, Grammarly, Quillionz) are limited

Together, these gaps define the new contribution of this chapter: a detailed, context – sensitive examination of three complementary AI tools within technical English education in Ukraine – grounded in both cognitive theory and current geopolitical realities. the current article deliberately focuses on unresolved problems: adapting this research to technical university contexts in Ukraine, designing educator-mediated AI use, and evaluating impact under real-world, disrupted learning conditions.

However, this functional expansion of English instruction brings new challenges for educators. Traditional teaching models, focused largely on grammar-translation methods or content-based language learning, often prioritise correctness and reproduction over exploration and critical engagement. While these methods may yield short-term linguistic gains, they do little to cultivate the kind of deep, transferable thinking skills that technical students need in order to thrive in their future workplaces. As a result, there is a growing imperative to design English for Specific Purposes (ESP) curricula that actively promote cognitive engagement – that is, the mental investment learners make in understanding and manipulating knowledge rather than merely receiving it passively.

Cognitive engagement, as understood in educational psychology, refers to the extent to which students are mentally involved in the learning process. It is typically associated with behaviours such as questioning assumptions, evaluating evidence, drawing inferences, and reflecting on one's own thought processes. This form of engagement stands in contrast to surface learning, which is often characterised by memorisation without understanding or the completion of tasks with minimal effort (*Fredricks, Blumenfeld & Paris, 2004*). Critical thinking, closely related to cognitive engagement, is commonly defined as the capacity to analyse, synthesise, and evaluate information in a logical and reflective manner (*Facione, 2011*). In technical English education, these abilities are vital (*Nykyporets, 2024*) not only for comprehending domain-specific texts, but also for adapting communication strategies to novel and complex situations.

Both concepts align closely with the upper levels of Bloom's revised taxonomy – namely, applying, analysing, evaluating, and creating (*Anderson & Krathwohl, 2001*). These higher-order thinking skills enable learners to transcend the mere recollection of facts and instead engage in more sophisticated cognitive activities such as interpreting technical data, formulating hypotheses, or constructing well-reasoned arguments in writing. For students in technical fields, the development of these skills in English is doubly significant, as it supports both linguistic competence and professional growth.

Yet fostering these outcomes through conventional teaching approaches can be exceedingly difficult. Lectures, grammar exercises, and static reading comprehension tasks rarely afford students the opportunity to interact with language in ways that demand deep thought or personal interpretation. Moreover, large class sizes, rigid curricula, and the limited availability of qualified ESP instructors often constrain the extent to which critical thinking can be incorporated into lesson design. In many Ukrainian technical universities, these challenges are further compounded by infrastructural limitations and the urgent need to adapt pedagogical approaches amid conditions of wartime disruption and displacement.

It is within this context that Artificial Intelligence (AI) emerges as a potentially transformative force. Far from replacing teachers, AI tools offer (*Kot, 2024*) novel means of scaffolding learning and customising instruction. Unlike static materials, AI-powered platforms are capable of generating real-time, context-sensitive feedback, adapting content to individual learner needs, and engaging students in interactive, dialogic processes. Such tools align well with constructivist principles of learning, which posit that knowledge is not passively received but actively constructed through experience and reflection. In the language classroom, this means that AI can help (*Nykyporets, 2025*) learners engage with content in ways that stimulate curiosity, provoke analysis, and encourage creative expression – all central components of cognitive engagement.

Furthermore, AI tools can help address some of the persistent shortcomings of traditional instruction. For example, a student who submits a technical report might

receive only limited feedback from a busy lecturer. However, with an AI-based writing assistant, the same student can receive instant, iterative suggestions for improving coherence, clarity, and grammatical accuracy. Similarly, while a teacher may not have time to craft higher-order thinking questions for every lesson, an AI platform like Quillionz or Twee can automatically generate comprehension and analysis questions from domain-specific texts, thereby supporting students in developing deeper understanding. When used appropriately, these tools become not shortcuts, but springboards – allowing students to explore content more fully, take intellectual risks, and monitor their own progress.

Of course, the effectiveness of these technologies is not inherent; it depends on how they are integrated into pedagogy. If AI tools are used merely to automate grammar correction or translate unfamiliar terms, they risk reinforcing surface learning habits. But when employed as cognitive partners – tools that provoke inquiry, offer alternative perspectives, or guide students through reflective processes – they can support the very types of engagement that traditional instruction often struggles to sustain.

This chapter proceeds with a detailed analysis of three specific tools – **ChatGPT, Grammarly, and Quillionz** – all of which are readily accessible to students and educators in the Ukrainian educational context. Each of these tools offers distinct affordances for fostering critical thinking, metacognitive awareness, and meaningful interaction with technical content. By examining how these platforms can be leveraged within technical English instruction, the discussion seeks to illuminate both the possibilities and the pedagogical principles that should guide the use of AI in supporting deep cognitive engagement.

This focus is particularly timely, as many Ukrainian universities continue to operate in hybrid or asynchronous formats due to security concerns and infrastructural instability caused by the ongoing war. In such disrupted learning environments, where access to teacher support may be irregular or delayed, AI tools can provide a much-needed sense of continuity and intellectual partnership. Students who are displaced, learning from temporary shelters, or facing emotional fatigue often find in these

platforms a form of stability and guided interaction that extends beyond the classroom. Moreover, the capacity of these tools to offer immediate, personalised feedback can help learners sustain motivation and improve performance in real time. Unlike static textbooks or pre-recorded lectures, AI-powered applications can adapt dynamically to students' inputs, thereby encouraging active participation and deeper engagement with language tasks. This responsiveness is crucial in technical English, where clarity, precision, and contextual understanding are paramount. In addition, AI tools can function as equalising agents, helping bridge the gap between students with varying levels of preparation or digital access. Yet, it is equally important to critically assess how these tools are introduced and framed within instructional design. Without careful moderation and reflective pedagogy, there is a risk that technology may reinforce superficial engagement rather than foster genuine critical inquiry. Therefore, this analysis aims not only to showcase the tools' utility but also to advocate for their thoughtful, ethically informed application in technical language education during times of crisis.

Practical analysis of AI tools.

The integration of Artificial Intelligence into language education is no longer an abstract concept but a practical necessity – especially in contexts where traditional educational infrastructures have been disrupted or rendered fragile. In modern Ukraine, where the war has forced many educators and students to relocate, to adapt to blended or remote learning, and to operate under psychological strain, the availability of adaptable, intelligent, and autonomous digital learning tools has become (Ibrahimova, 2021) a vital supplement to teacher-led instruction. The following analysis explores the practical use of three AI-driven platforms – ChatGPT, Grammarly, and Quillionz – through the lens of fostering cognitive engagement and critical thinking in the learning of technical English. Each of these tools can function as a type of cognitive prosthesis – a support system that not only assists, but extends the learner's ability to process, question, and create meaning through language.

ChatGPT: dialogic thinking in action.

Among the most transformative tools to enter the educational landscape in recent years is ChatGPT, a large language model developed by OpenAI. Designed to simulate human-like dialogue, it enables learners to interact with a virtual interlocutor that can answer questions, explain complex topics, reformulate texts, and engage in open-ended discussion. Its potential in the technical English classroom lies in its dialogic nature – it invites students into a space of continuous inquiry, where language is not consumed passively but constructed actively.

One of ChatGPT's most cognitively engaging features is its ability to generate and respond to questions. For instance, a student might input a technical term such as "*photovoltaic efficiency*", and the model can return not only a definition but also pose follow-up questions such as: "*What factors influence photovoltaic efficiency in real-world applications?*" or "*How does this concept relate to thermal losses?*" This form of reciprocal questioning stimulates critical thinking, as it challenges students to examine connections, underlying principles, and practical consequences – all while expanding their domain-specific vocabulary.

ChatGPT also excels in paraphrasing and summarisation, allowing students to evaluate multiple phrasings of the same content. This supports metalinguistic awareness and helps learners develop an ear for scientific register and clarity. For example, when tasked with rewriting a technical definition in simpler terms for a lay audience, students must negotiate meaning, tone, and accuracy – a process that inherently involves higher-order thinking.

In the context of technical English, such exercises are particularly valuable, as they train learners to navigate between specialised discourse and more general communicative modes. This ability is essential not only for academic tasks but also for future professional roles, where engineers and IT specialists must often explain complex systems to clients, stakeholders, or cross-functional teams. Moreover, the act of paraphrasing requires students to internalise terminology, reframe information without distorting meaning, and reflect on lexical choices – all of which contribute to deeper semantic processing. ChatGPT's instant feedback on reworded content provides

learners with a low-stakes environment to experiment with language and refine their output. This iterative engagement fosters autonomy and encourages risk-taking, both of which are crucial for language development at advanced levels. It also supports differentiation, allowing stronger students to pursue more nuanced reformulations while offering foundational guidance to those who may struggle. In settings where human feedback is limited due to war-related disruptions or remote teaching, ChatGPT effectively fills the role of a responsive peer or tutor. Importantly, it exposes learners to a variety of syntactic structures and discourse strategies, broadening their expressive range. When used reflectively, this exposure contributes to stylistic maturity and rhetorical flexibility. Thus, beyond merely rephrasing text, ChatGPT enables a cognitive apprenticeship in how meaning is constructed and conveyed within technical domains.

A practical task might involve students using ChatGPT to simulate a real-world interaction, such as explaining a technical process during a job interview or responding to an engineering client's inquiry. In such exercises, the tool becomes more than a language assistant – it becomes a partner in simulating professional discourse, thus bridging classroom practice with future career realities. For displaced Ukrainian students who may be studying remotely from basements, shelters, or foreign hostels, this accessibility to a responsive, low-bandwidth conversational tutor can be especially empowering.

Table 2.**Key ChatGPT parameters relevant to English language learning**

Parameter	Description	Educational implication
temperature	Controls the randomness of output. Values range from 0.0 (deterministic) to 1.0 (more creative or varied output).	Lower values (e.g. 0.2–0.4) are ideal for grammar correction and academic paraphrasing, while higher values (e.g. 0.7–0.9) are better for creative writing.
top_p (nucleus sampling)	Determines the cumulative probability mass from which the model draws responses. Often used in conjunction with temperature.	Affects the diversity of vocabulary and syntactic structures in responses. Helps students compare formal and informal variants or idiomatic expressions.
max_tokens	Sets the maximum number of tokens (words + subwords) in the generated output.	Useful in summarisation tasks where students practise condensing long texts. It supports academic abstract writing and note-taking.
stop	Defines stopping conditions based on certain words or punctuation.	Enables teachers to build guided dialogues or cut off responses at specific points for fill-in-the-gap or prediction exercises.
prompt engineering	Refers to the formulation of input to guide the model's output.	Central to learner autonomy: students learn to ask better questions, which strengthens critical thinking and questioning skills.
token probability	The model assigns probabilities to each possible next token based on context using: $P(w_t w_1, w_2, \dots, w_{t-1})$	This reflects the statistical logic behind natural language generation and can be shown to students when discussing collocations, word predictability, etc.
embedding vectors	Words are internally represented as dense vectors in semantic space. Semantic similarity between tokens is measured via cosine similarity: $\cos(\theta) = (A \cdot B) / (\ A\ \ B\)$	Understanding how the model “knows” synonyms or paraphrases can support vocabulary development and semantic analysis tasks.

Source: created by authors.

Extended description of parameters and educational value is as follows.

“Temperature” and “top-p”. These two parameters work together to modulate lexical and syntactic creativity. For example, by setting temperature=0.2, learners will

receive consistent, grammatically optimal responses – ideal for formal report writing. Conversely, with temperature=0.9 and top_p=0.95, the model may suggest more unusual, idiomatic, or humorous expressions, useful in practising register shifting and stylistic analysis.

“Max tokens”. By adjusting max_tokens, learners can practise compressing or expanding text. This parameter is valuable in activities such as writing research abstracts, summarising engineering manuals, or engaging in one-sentence debates. It also allows the teacher to create tight, focused prompts for grammar or structure drills.

“Prompt engineering”. Mastering prompt design becomes a language skill in its own right. For instance, students who learn to request: *"Explain the difference between active and passive voice with technical examples"* begin to engage with meta-linguistic inquiry, thus fostering independence in both language and cognitive development.

“Token probability” and “embeddings”. Behind the scenes, ChatGPT uses probabilistic reasoning based on prior token contexts. Introducing students to basic formulas (such as the cosine similarity function) in simplified form can be used to explain why some paraphrases are accepted while others are flagged. This has a motivating effect for STEM students, who often appreciate quantitative insights into linguistic processes.

The information presented in the table 2 is based on OpenAI’s official documentation on ChatGPT parameters (<https://platform.openai.com/docs/api-reference/chat>) and their behavioural effects in language generation tasks. Additional insights were derived from recent empirical studies on AI-assisted language learning given in the article, which examined how variations in model configuration influence learner engagement and output quality. These findings were synthesised and contextualised specifically for technical English instruction within the framework of cognitive and metacognitive learning theories.

Grammarly: enhancing metacognition in technical writing.

While ChatGPT facilitates exploration and interaction, Grammarly plays a more introspective role in language development. As an AI-powered writing assistant, Grammarly offers real-time feedback on grammar, punctuation, cohesion, style, and

tone. Its strength lies not only in correcting errors but in prompting students to reflect on why changes are necessary – thereby fostering metacognitive awareness in writing.

This metacognitive engagement is critical in technical English, where the nuances of precision, formality, and consistency are fundamental to effective communication. Grammarly's ability to offer suggestions tailored to the text's purpose – whether it be an academic paper, lab report, or business correspondence – makes it a versatile tool across various genres. For learners in technical fields, it reinforces the importance of logical coherence and lexical accuracy, which are often undervalued in general language instruction. By interacting with Grammarly's suggestions, students are invited into a dialogue with the text, evaluating not just what they wrote, but how it might be interpreted by a professional audience. This recursive process of writing, reviewing, and revising mirrors the authentic writing practices of engineers, researchers, and technicians. In environments where timely feedback from instructors is not always feasible – such as during periods of remote learning or war-induced disruption – Grammarly can provide a consistent source of formative support. It enables (*Miranty et al., 2025*) students to identify patterns in their own writing errors and track improvements over time, thereby cultivating a sense of ownership and progression in their language development.

Moreover, the immediate feedback reduces cognitive overload by isolating specific issues for targeted correction, a feature particularly beneficial to students juggling multiple technical disciplines. Teachers, too, benefit from Grammarly's summaries of student performance, which can inform individualised instruction and highlight common areas for class-wide intervention. While the tool is not infallible and should not be relied upon as a final arbiter of correctness, it nevertheless functions as a valuable bridge between drafting and professional-level writing. Importantly, students begin to internalise stylistic conventions and rhetorical norms, gaining familiarity with the expectations of scientific and technical discourse. In this way, Grammarly supports not only language accuracy but also the gradual development of a technical writer's voice – an asset that carries beyond the classroom and into the learner's future professional identity.

In the context of technical English, where clarity, conciseness, and accuracy are paramount, Grammarly serves as a mirror for the student's linguistic choices. For example, a student writing a laboratory report may receive feedback that a particular sentence is overly verbose or lacks subject-verb agreement. This feedback is often accompanied by explanations and alternative formulations, allowing learners to self-correct and revise iteratively. Over time, such feedback loops strengthen the student's internalised understanding of written norms, which is particularly valuable in professional and academic genres.

Table 3.

Examples of Grammarly-assisted corrections in technical English writing

Field	Original sentence	Grammarly suggestion	Improvement description
Power engineering	<i>The transformer is not working <u>proper</u> and the voltage is unstable which may damage the system components.</i>	<i>The transformer is not working <u>properly</u>, and the voltage is unstable, which may damage system components.</i>	Corrected adverb usage, added comma for clarity, and removed unnecessary article.
Green power	<i>Using solar panels can reduce emission and <u>its</u> better for environment.</i>	<i>Using solar panels can reduce emissions, and <u>it's</u> better for the environment.</i>	Corrected noun form and spelling, fixed contraction, and added necessary article.
Power engineering	<i>The student <u>suggest</u> to increase the power output by adjusting the turbine blades position.</i>	<i>The student <u>suggests</u> increasing the power output by adjusting the position of the turbine blades.</i>	Fixed subject-verb agreement, refined verb form, and improved word order.
Environmental protection	<i>Coal burning is main reason of air <u>polution</u> in industrial region.</i>	<i>Coal burning is the main reason for air <u>pollution</u> in industrial regions.</i>	Added missing article and preposition, corrected spelling and plural form.

Source: created by authors.

These kinds of automated yet context-aware interventions not only helped improve the linguistic correctness of the students' reports and presentations but also deepened their awareness of how language precision reflects technical reliability – a critical feature in fields where misinterpretation can have real-world consequences.

This iterative process not only enhances grammatical competence but also fosters a sense of linguistic responsibility, as students become more aware of how their writing is perceived by different audiences. In technical disciplines, where even minor ambiguities can lead to serious misinterpretations, such attention to form and function is especially critical. Grammarly encourages learners to make informed decisions about sentence construction, lexical precision, and rhetorical balance. It helps students to identify common pitfalls – such as overuse of passive voice, inconsistent terminology, or nominalisations – which are frequently encountered in scientific and technical writing.

Besides, the platform's data-driven approach aligns well with the analytical mindset of students in STEM fields, who often appreciate objective indicators of improvement. By reviewing patterns in their own writing history, learners can track their development over time, which contributes to a greater sense of progress and self-efficacy. Teachers, too, can use this feedback diagnostically, identifying recurring issues across student groups and tailoring instruction accordingly. In war-affected educational settings, where teacher-student contact may be fragmented or asynchronous, Grammarly becomes a vital pedagogical aid that extends the reach of instruction beyond the classroom. Its 24/7 availability offers students a stable learning companion in times of uncertainty and disruption. However, the tool's true educational value emerges when its suggestions are critically evaluated, not simply accepted, prompting students to engage in reflective decision-making. This cultivates a habit of mindful revision, turning writing into an active, iterative process rather than a one-time task. In this way, Grammarly supports not only the mechanics of writing but also the development of academic and professional identity through language.

Table 4.**Grammarly features which help in English language learning**

Feature	Description	Educational implication
Real-time grammar and punctuation checking	Automatically detects grammatical errors, punctuation issues, and basic sentence structure problems as the student writes.	Supports immediate corrective feedback, helping learners develop grammatical accuracy and fluency through iterative writing.
Tone and formality detection	Analyses the tone of the writing and offers suggestions to make it more formal, neutral, or appropriate for the target audience.	Assists students in adjusting their writing style for technical, academic, or business contexts, reinforcing genre awareness.
Vocabulary enhancement suggestions	Identifies repetitive or imprecise word usage and proposes alternatives with more precision or stylistic appropriateness.	Encourages lexical variety and domain-specific vocabulary usage, which are crucial for technical English learners.
Clarity and conciseness feedback	Highlights redundant phrases and convoluted sentence constructions, promoting clearer and more direct expression.	Trains students to write with precision and efficiency, qualities essential in scientific and technical communication.
Plagiarism detection (Premium)	Scans the text against a vast database of online content to flag potential plagiarism.	Promotes academic integrity and teaches proper paraphrasing and citation techniques in research-based writing tasks.
Goal setting and audience adaptation	Allows the user to set specific writing goals based on audience type, formality, intent, and domain.	Fosters rhetorical awareness and adaptation, enabling learners to produce contextually appropriate writing for varied technical audiences.

Source: created by authors.

The information about Grammarly's features is based on the official documentation and product descriptions provided on Grammarly's website, which detail its educational and linguistic capabilities (<https://www.grammarly.com>). Additional insights are drawn from empirical studies such as Yawiloeng (2025), who analysed Grammarly's impact on ESL students' writing quality and metacognitive development in academic contexts. These sources were selected for their relevance to applied linguistics and technical English instruction, and they inform the pedagogical framing of Grammarly as a reflective tool for language development.

Furthermore, Grammarly's tone detector and formality indicators can help students adjust their writing to suit different rhetorical contexts – whether drafting a business email, preparing a grant proposal, or documenting the results of an

engineering test. In a war-time educational context, where face-to-face writing tutorials may be unavailable, Grammarly can serve as a surrogate mentor, offering guidance when human feedback is delayed or impossible. The psychological effect of “not writing alone” is also significant: the presence of an always-available digital reader can encourage students to persist through tasks they might otherwise find overwhelming.

Quillionz: empowering students as question designers.

Less widely known than the previous two, Quillionz is a specialised AI tool designed to generate questions from user-provided texts (*Mittal, 2024*). While it may appear simplistic at first glance, its pedagogical implications are profound. In technical English instruction, students often read complex materials without engaging in the deeper questioning that leads to understanding. Quillionz addresses this by modelling the process of inquiry and encouraging students to become question-creators, rather than passive recipients of information.

This transformation from answerer to questioner is central to developing higher-order thinking skills and aligns with inquiry-based learning approaches widely endorsed in modern pedagogy. In the context of technical education, where learners frequently encounter dense and specialised texts, the ability to formulate meaningful questions is not just beneficial – It is essential for comprehension and application. By generating multiple question types, such as factual, conceptual, and inferential prompts, Quillionz supports learners in approaching the same content from different cognitive angles. This multidimensional engagement enables students to uncover layers of meaning, detect ambiguities, and interrogate the relevance of what they read.

Moreover, when students input subject-specific content – such as engineering manuals, programming documentation, or scientific abstracts – the AI’s generated questions serve as a scaffold for both vocabulary retention and concept clarification. For example, a paragraph describing thermodynamic systems can be broken down into targeted queries that assess both terminology recognition and process understanding. This not only enhances subject-matter mastery but also trains students to think like examiners or reviewers – roles that demand clarity, precision, and depth.

Table 5.

Examples of Quillionz-assisted question generation in Power Engineering education

Topic	Original text input	Quillionz-generated question	Educational value / outcome
Thermodynamic systems	The first law of thermodynamics states that energy cannot be created or destroyed, only converted from one form to another.	What does the first law of thermodynamics state about energy conversion?	Helps reinforce conceptual understanding and recall of fundamental principles.
Electric power generation	In a hydroelectric power plant, potential energy stored in water is converted into mechanical energy and then into electrical energy.	How is energy transformed in a hydroelectric power plant?	Supports comprehension of process sequences and energy transformation.
Transformer operation	A transformer changes the voltage of alternating current electricity by using magnetic induction between coils.	What is the role of magnetic induction in a transformer?	Promotes deeper analysis of cause-effect relationships in system operation.
Synchronous generators	Synchronous generators produce electricity by rotating a magnetic field inside stationary windings.	How does a synchronous generator produce electricity?	Assesses ability to interpret mechanical-electrical conversion processes.

Source: created by authors.

The editable nature of Quillionz's output further contributes to its pedagogical value. Learners are not bound by the AI's formulations but are encouraged to revise and refine questions, thereby engaging in a meta-cognitive process that strengthens critical language awareness. This is particularly important in technical English, where poorly worded questions can lead to miscommunication or conceptual confusion. Furthermore, students begin to internalise the characteristics of high-quality assessment items, a skill that can transfer to peer review, collaborative projects, or future teaching roles.

In war-affected Ukrainian institutions, where academic schedules are disrupted and students must often study independently, tools like Quillionz offer structured learning opportunities that would otherwise require significant instructor input. It allows for the asynchronous reinforcement of reading strategies and gives learners the means to assess their understanding outside traditional testing environments. In all, by shifting the focus from memorisation to meaningful interrogation, Quillionz fosters deeper engagement with technical content and contributes to the development of agile, autonomous learners equipped for both academic and professional success.

After inputting a paragraph or short technical article, users receive a range of automatically generated question types – including factual, conceptual, and analytical. This immediate transformation of static text into dynamic engagement fosters reading comprehension at a deeper level. Importantly, it also demystifies the process of question formation, which is itself a critical thinking skill. For Ukrainian students preparing for exams, interviews, or project defence presentations, practising the formulation of high-quality questions can be a strategic advantage.

Educators can further leverage Quillionz by asking students to compare the AI-generated questions with their own, critique them, or modify them to align better with specific learning outcomes. In doing so, students reflect on not only *what* they are learning, but *how* and *why* – which are hallmarks of meaningful cognitive engagement. This reflective comparison cultivates metacognitive awareness, enabling students to evaluate the quality and relevance of questions and to better understand the underlying principles of effective communication in technical contexts. Such practices also empower learners to take a more active role in shaping their learning process, transforming them from passive consumers of content into critical evaluators and co-creators of knowledge. Over time, this habit of analytical question refinement not only deepens subject-matter comprehension but also strengthens students' ability to transfer these critical thinking skills to unfamiliar texts, tasks, and professional situations.

Table 6.

Quillionz features relevant to learning technical English

Feature	Description	Educational implication
Automatic question generation	Generates factual, inferential, and conceptual questions from user-inputted text passages.	Enables students to practise comprehension, deepen engagement with technical materials, and prepare for assessments based on real subject content.
Question type variety	Produces multiple types of questions (e.g. multiple choice, short answer, recall-based).	Supports different levels of Bloom's taxonomy and allows for both low- and high-stakes formative assessment in technical English contexts.
Custom content upload	Allows users to input subject-specific or technical texts for question generation.	Promotes discipline-specific vocabulary retention and strengthens understanding of key technical concepts through active engagement.
Editable question output	Offers the ability to review, modify, and refine generated questions before using them in practice or quizzes.	Encourages metacognitive awareness by prompting students or teachers to assess the clarity, relevance, and depth of questions.
Quillionz brain (AI engine)	Uses natural language processing and AI to identify important concepts and generate relevant questions.	Introduces learners to AI-enhanced reading strategies, helping them discern core ideas and reframe them as questions, which supports critical reading skills.

Source: created by authors.

Taken together, these three tools offer distinct but complementary avenues for activating cognitive engagement in technical English education. ChatGPT stimulates dialogic reasoning and lateral thinking, ideal for exploring unfamiliar concepts and applying knowledge in new contexts. Grammarly promotes inward reflection, supporting the iterative refinement of technical writing and helping students regulate their own linguistic output. Quillionz, in turn, encourages a metacognitive stance toward reading and learning, prompting students to interrogate the material rather than accept it at face value. When strategically combined, these tools create a multi-layered learning environment in which students engage with language not only as users, but as analysts, editors, and questioners. This integrated approach aligns with contemporary

pedagogical goals that prioritise autonomy, critical thinking, and disciplinary literacy in English for engineering and related technical domains.

Table 7.

Comparison of AI tools for learning ESP English: ChatGPT, Grammarly, and Quillionz

Tool	Primary function	Cognitive skill focus	ESP application	Pedagogical affordances
ChatGPT	Generative AI for interactive dialogue and content creation	Critical thinking, problem-solving, dialogic reasoning	Explaining complex technical concepts, simulating interviews, generating paraphrases and summaries	Encourages exploration, supports higher-order thinking, provides varied linguistic input
Grammarly	AI-powered writing assistant with real-time grammar and style feedback	Metacognitive awareness, accuracy monitoring, self-regulation	Editing technical reports, refining academic writing, adjusting tone and clarity	Reinforces formal conventions, improves linguistic precision, offers revision history for reflection
Quillionz	AI-driven question generation based on user-provided texts	Reading comprehension, analytical thinking, reflective questioning	Creating formative assessments, identifying key concepts in technical materials, building vocabulary tests	Fosters inquiry-based learning, supports formative assessment, empowers students as question-designers

Source: created by authors.

Critical thinking is a foundational competency in English for Specific Purposes, particularly in technical and professional domains where accuracy, clarity, and informed judgement are essential. It enables students not only to understand specialised content but also to question, evaluate, and reframe it within appropriate disciplinary contexts. In ESP education, especially for engineering, scientific, or business fields, students must go beyond memorisation (*Nykyporets, 2024*) and develop the ability to interpret, analyse, and communicate complex information effectively. The growing

integration of Artificial Intelligence into education provides powerful tools to support this process, with ChatGPT, Grammarly, and Quillionz offering complementary cognitive and linguistic benefits.

ChatGPT enhances dialogic reasoning by enabling students to explore concepts interactively through structured or exploratory questioning. By asking follow-up questions or simulating academic and workplace scenarios, students engage in real-time conceptual negotiation, which promotes deeper understanding. ChatGPT also supports the development of problem-solving skills by offering multiple perspectives on the same issue, prompting learners to compare and assess alternative explanations. In this way, it serves as a digital interlocutor that helps students articulate and refine their thinking.

Grammarly, by contrast, promotes critical self-evaluation and metalinguistic awareness. Its real-time feedback encourages students to examine their writing choices, understand grammar and style conventions, and reflect on how effectively they are communicating their ideas. This iterative process of drafting and revising cultivates habits of self-correction and independence, which are central to academic and professional success. Grammarly's tone and clarity suggestions further enable students to consider audience expectations and discourse appropriateness – both of which require critical sensitivity to context.

Quillionz introduces learners to the practice of generating and evaluating questions, a key skill in critical reading and content interrogation. By producing a range of question types – from factual to inferential – it helps students identify core concepts, test comprehension, and challenge superficial reading habits. When students compare AI-generated questions with their own or refine them collaboratively, they learn to evaluate information structure, determine relevance, and reflect on their learning strategies. This process strengthens both content retention and higher-order thinking.

Together, these tools offer a dynamic framework for cognitive engagement in ESP contexts. ChatGPT stimulates creative and conceptual exploration, Grammarly refines expression and fosters self-regulation, and Quillionz supports critical interaction with reading materials. They shift the learning experience from passive

reception to active construction of knowledge. Especially in technical disciplines, where precision and critical interpretation are paramount, these tools provide scaffolds that enable students to build confidence, fluency, and intellectual agility. Importantly, they also model reflective practices that can be transferred beyond the classroom, into research, internships, or professional communication. In an age where information is abundant and often unverified, cultivating critical thinking is not just educationally desirable – it is essential. These AI-driven platforms, when used thoughtfully and with pedagogical guidance, can be powerful allies in nurturing the analytical, responsive, and articulate communicators demanded by today's professional environments.

From the perspective of cognitive demands, ChatGPT engages the highest levels of Bloom's taxonomy – especially *analysing*, *evaluating*, and *creating* – by involving students in generative, open-ended tasks. Grammarly targets the middle tiers, such as *applying* and *analysing*, by guiding students in revising and restructuring their work. Quillionz primarily supports *understanding* and *analysing*, but it also scaffolds movement towards creation when students are tasked with generating their own questions.

This differentiation in cognitive engagement allows educators to design layered activities that address various stages of learning, moving students progressively from comprehension to independent production. For instance, a learning sequence might begin with students using Quillionz to identify key ideas and terminology, followed by Grammarly-assisted drafting of technical summaries, and culminating in ChatGPT-facilitated simulations of professional scenarios. Each tool, therefore, becomes a stepping stone within a structured pedagogical framework aligned to Bloom's taxonomy.

Additionally, these tools respond differently to learner autonomy: while Grammarly provides corrective scaffolding, ChatGPT invites generative exploration, and Quillionz encourages reflective interrogation. This balance supports diverse learner profiles, including those with varying levels of confidence, proficiency, and prior subject knowledge. In war-affected Ukrainian classrooms, where cognitive

fatigue and fragmented attention are common, the strategic deployment of tools according to their cognitive load can help avoid learner overwhelm.

It allows instructors to calibrate challenge and support, ensuring that engagement remains productive rather than frustrating. Moreover, by explicitly linking tasks to cognitive processes, students gain a better understanding of how learning works – an awareness that enhances their ability to self-regulate and transfer skills across contexts. As such, the coordinated use of ChatGPT, Grammarly, and Quillionz offers not only technological innovation, but a psychologically responsive and intellectually principled approach to ESP instruction.

Analytical thinking also enables students studying ESP English to deconstruct complex disciplinary texts, identify key concepts, and evaluate the relevance and accuracy of technical information. It also empowers them to adapt their language use to specific professional contexts, fostering precision, clarity, and informed decision-making in communication.

In ESP contexts, especially within fields like engineering, business, or medicine, students are often required to interpret data, compare arguments, and make linguistically sound, content-rich decisions. Analytical thinking supports their ability to distinguish between factual information and assumptions, which is vital when working with reports, case studies, or technical manuals. It also enhances (Nykykyporets, 2023) *their* skill in identifying implicit meaning, logical structure, and rhetorical strategies in specialised texts. This is particularly important when learners are expected to engage in academic writing, technical documentation, or professional correspondence.

By developing analytical thinking, students become more adept at recognising inconsistencies, evaluating evidence, and constructing coherent arguments – all of which are key to producing credible and contextually appropriate discourse. Furthermore, analytical reasoning enables learners to reflect on their own linguistic performance, improving their ability to self-edit and justify their lexical and grammatical choices. It also facilitates peer collaboration, as students can engage in more constructive dialogue and critique when discussing discipline-specific content.

In listening and speaking tasks, analytical skills help students to follow complex instructions, synthesise spoken input, and respond with clarity and precision. Ultimately, these capabilities contribute to more effective knowledge transfer and professional adaptability. In a world where English is the dominant medium for global technical communication, analytical thinking is not just a cognitive asset – it is a prerequisite for success.

In terms of application scope, all three tools are accessible via standard internet connections and can be used asynchronously – a feature that is critically important for Ukrainian learners facing power outages, displacement, or limited synchronous instruction. Each tool, when integrated thoughtfully and with clear pedagogical intent, contributes to the cultivation of language skills that are not merely performative, but genuinely empowering – equipping students to think independently, communicate precisely, and participate confidently in the global technical community.

Their asynchronous availability allows students to engage with learning materials on their own terms, whether during moments of relative stability or in fragmented intervals dictated by unpredictable external conditions. This flexibility is particularly significant in the Ukrainian context, where students may be navigating the demands of relocation, shared living spaces, or irregular access to electricity and mobile networks.

Moreover, the low entry threshold for these tools – requiring only basic digital literacy and access to a web browser – enhances inclusivity and reduces technological barriers to participation. Importantly, all three platforms support iterative engagement, allowing learners to revisit tasks, refine their responses, and track their own progress over time. Such features are instrumental in fostering persistence and resilience – qualities essential in both language learning and broader life under crisis. From a student's curricular perspective, the tools' compatibility with asynchronous learning also aligns well with modular course design and self-paced instruction. This enables educators to assign AI-supported activities as part of flipped classroom models or blended formats, enhancing continuity in disrupted academic schedules in the difficult times of long and cruel russian-Ukrainian war of aggression.

Furthermore, each tool can be embedded within broader learning management systems or shared through messaging platforms, thereby integrating seamlessly into existing institutional frameworks. As Ukraine continues to rebuild and reimagine its educational infrastructure amid wartime realities, scalable, accessible, and adaptive solutions such as these represent not just temporary aids, but long-term assets for future-facing pedagogy. Their value lies not only in content delivery but in sustaining a sense of academic normalcy and intellectual agency – both of which are foundational to the country's human capital and post-war recovery.

Examples of effective use of AI tools in learning ESP English at Vinnytsia National Technical University.

This study was conducted over two consecutive academic semesters of 2024-2025 year at the Faculty of Electrical Power Engineering and Electromechanics, Vinnytsia National Technical University (VNTU), among five groups of 1st - and 2nd -year students (n = 89). Each group consisted of 17-18 participants with comparable baseline English proficiency based on the initial diagnostic assessment.

Participants were divided into five groups: Group 1 used ChatGPT, Group 2 used Grammarly, Group 3 used Quillionz, Group 4 served as the control group (no AI tools), and Group 5 had access to all three tools. A mixed-methods approach was applied, combining pre-test/post-test quantitative analysis with rubrics-based qualitative evaluation. This allowed for a comprehensive assessment of both measurable language gains and observable behavioural changes in students' engagement with English for engineering. Quantitative data captured progress in reading, writing, grammar, and speaking performance, while qualitative insights illuminated shifts in learners' metacognitive awareness, critical thinking, and interaction with AI tools.

Scores were standardised on a 100-point scale across five language skill areas: reading comprehension, writing clarity, grammar accuracy, dialogue performance, and monologue fluency. The final score was computed as an average percentage improvement relative to initial test results. Statistical reliability was confirmed using the mean percentage increase formula: $\% \Delta = ((\text{Post} - \text{Pre}) / \text{Pre}) \times 100$.

All data were collected in compliance with ethical standards; students participated voluntarily and provided written consent for the use and publication of anonymized results.

Table 8.

Comparative impact of AI Tools on the development of English for engineering skills

Group	Reading (%)	Writing (%)	Grammar (%)	Dialogue (%)	Monologue (%)
Group 1 (ChatGPT)	Medium 23%	Medium 21%	Low-Medium 15%	High 37%	High 34%
Group 2 (Grammarly)	Low-Medium 17%	High 39%	High 41%	Low-Medium 19%	Medium 26%
Group 3 (Quillionz)	High 36%	Medium 24%	Medium 22%	Low 11%	Low-Medium 17%
Group 4 Control (No AI)	Low 8%	Low 11%	Low 9%	Low 10%	Low 12%
Group 5 (All tools)	Very High 51%	Very High 57%	High 48%	Very High 55%	Very High 53%

Source: created by authors.

To calculate percentage improvement in each language skill area, the following formula was applied:

$$\% \Delta = ((\text{post-test score} - \text{pre-test score}) / \text{pre-test score}) \times 100$$

Where $\% \Delta$ is the percentage improvement, and pre-test and post-test scores represent averaged group performance before and after the intervention respectively.

Pedagogical implications and future directions.

The integration of Artificial Intelligence into the teaching of technical English represents not only a response to the global digital turn in education, but a particularly urgent and context-sensitive adaptation in the Ukrainian academic landscape. In this chapter, we have examined how three AI tools – ChatGPT, Grammarly, and Quillionz – can meaningfully contribute to the activation of students’ cognitive engagement, a pedagogical goal of increasing importance in technical universities. Each tool, with its unique affordances, supports a different facet of the learning process, helping students move from passive consumption to active knowledge construction.

ChatGPT engages learners through interactive, dialogic thinking, stimulating critical reasoning and problem-solving by encouraging students to generate and respond to complex questions. Grammarly cultivates metacognitive reflection in writing, offering learners immediate feedback loops that promote clarity, precision, and stylistic awareness in technical communication. Quillionz, in turn, enhances reading comprehension and higher-order thinking by guiding students in the process of question generation, positioning them not only as recipients of information, but as interrogators and constructors of meaning. Together, these tools help to reimagine technical English instruction as a space where cognitive development and language learning are mutually reinforcing.

From a pedagogical perspective, the classroom implications are both promising and practical. These tools can be seamlessly integrated into a range of learning activities and assessment formats. Teachers might encourage students to use ChatGPT for brainstorming project ideas, simulating professional interviews, or exploring alternative explanations of technical concepts. Grammarly can be used not simply as a corrective tool, but as a reflective one – where students submit drafts, revise based on AI feedback, and then discuss those revisions in class. Quillionz can support formative assessment by enabling students to generate quiz questions or create study guides collaboratively. Each of these applications helps shift the instructional focus away from accuracy alone and towards thoughtful engagement with content, form, and audience.

Instructors can also design blended tasks that interweave all three tools, allowing students to engage with the same topic through multiple cognitive lenses – such as reading a technical passage, generating questions using Quillionz, discussing key concepts via ChatGPT, and refining a written summary through Grammarly. This multimodal approach reinforces learning by encouraging repetition across varied formats and platforms, each reinforcing a different dimension of understanding. Moreover, these tools promote learner autonomy, enabling students to take initiative, experiment with language use, and monitor their own progress. Such autonomy is particularly vital in contexts where face-to-face feedback is limited or delayed, as is

often the case in war-disrupted learning environments. Group projects, too, can benefit from these platforms; for example, students might co-develop interview simulations using ChatGPT scripts, peer-edit reports using Grammarly suggestions, and prepare quiz-style reviews for classmates via Quillionz. Teachers, meanwhile, gain access to valuable process data – including draft revisions, usage logs, and content creation histories – which can inform individualised feedback and targeted interventions.

The integration of these tools also supports differentiated instruction, as students with varying strengths can benefit from personalised AI interactions at their own pace. Importantly, this also allows educators to spend less time correcting surface-level language errors and more time engaging with students on substantive, content-driven issues. In doing so, classroom discourse can evolve from error correction to conceptual dialogue – a shift aligned with current theories of communicative and content-based language learning. Ultimately, these technologies offer not just practical enhancements, but opportunities to rethink classroom interaction and re-centre pedagogy around cognitive depth, reflection, and learner empowerment.

However, it is essential to reiterate that the successful implementation of these technologies hinges on their guided and intentional use. AI should be positioned as an assistant – not a replacement – for human instruction. If introduced without scaffolding, AI tools may lead to superficial engagement, overreliance, or even the erosion of critical judgment. There is a risk that students may defer too quickly to the output of a language model, accepting suggestions without reflection or mistaking fluency for accuracy. This is particularly concerning in the context of technical English, where precision and appropriateness are non-negotiable. Educators must, therefore, act as curators and moderators, helping students interpret, question, and sometimes challenge the outputs generated by AI.

These concerns are not merely theoretical. In wartime Ukraine, where educational continuity is strained and students often learn in fragmented, asynchronous environments – sometimes from temporary shelters or war-damaged homes – the temptation to outsource thinking is real. In such conditions, AI may appear as a lifeline. But if used uncritically, it can hinder the very resilience and independence that our

education system strives to foster in students living through conflict. Therefore, pedagogical strategies must include explicit instruction in AI literacy – helping both students and teachers to understand how these tools work, what their limitations are, and how to use them ethically and effectively.

AI literacy should not be treated as an optional digital skill, but rather as a core component of XXI-century language education – particularly within technical disciplines where the consequences of miscommunication can be critical. Students must be equipped not only to use these tools, but to evaluate their outputs critically, recognising patterns, inconsistencies, and stylistic mismatches that may compromise the communicative purpose of a text. This requires that educators go beyond tool demonstration and instead embed critical reflection, comparative analysis, and error-spotting tasks into AI-supported lessons. For example, learners can be asked to analyse (*Michalon, 2023*) multiple AI-generated responses to a technical prompt, identify flaws or omissions, and collaboratively revise them to align with authentic engineering discourse. Such activities not only reinforce linguistic accuracy but also develop learners' editorial judgement and domain-specific awareness.

Moreover, without explicit teacher mediation, there is a danger that students will accept AI suggestions as authoritative simply because they appear fluent or confident in tone. This "automation bias" must be actively countered through classroom discussion, critical incident analysis, and the cultivation of a questioning mindset. Teachers can model this by openly critiquing AI outputs in class, discussing how and why certain choices may be inappropriate in academic or professional contexts. Another crucial dimension is ethical awareness – students should be made conscious of the risks of plagiarism, misuse, or over-dependence on auto-generated content, particularly in environments where independent academic work is highly valued.

In the Ukrainian context, the development of such digital and ethical competencies is closely tied to the broader goal of fostering democratic resilience, intellectual autonomy, and national self-determination. In times of war, when traditional educational structures are weakened or under attack, the ability to think critically, question sources, and articulate one's own perspective becomes a form of

resistance and renewal. As such, responsible AI integration should be seen not only as a pedagogical strategy, but as a civic and psychological imperative. Institutions must therefore invest in professional development for instructors, ensuring they are prepared to guide students through this evolving digital landscape with confidence and care. In doing so, they uphold the role of the university not just as a transmitter of knowledge, but as a cultivator of discernment, accountability, and intellectual courage in times of uncertainty.

Looking ahead, several avenues for further research and development emerge. Firstly, we need longitudinal studies that examine the long-term impact of AI-supported instruction on students' critical thinking and language proficiency. Much of the current evidence is anecdotal or based on short-term interventions. Secondly, we must explore how AI tools can be adapted to Ukrainian-language contexts and integrated into bilingual or multilingual learning environments. Thirdly, given the emotional and psychological toll of war on both students and teachers, it would be valuable to investigate the potential affective dimensions of AI use – whether these tools can alleviate anxiety, promote persistence, or support students' sense of agency in times of disruption.

In all, we must work collectively to ensure that access to these tools is equitable. Rural schools, internally displaced students, and those with limited connectivity should not be left behind in the digital transformation of education. National policies and institutional strategies must prioritise digital infrastructure, professional development, and resource sharing – not as luxuries, but as necessities for academic survival and recovery.

The digital divide, if left unaddressed, risks deepening existing educational inequalities and disproportionately affecting vulnerable student populations. In the context of wartime Ukraine, this challenge is particularly acute, as many learners are studying from unstable environments with limited or intermittent access to electricity, internet, or safe learning spaces. Providing mobile-friendly, low-bandwidth versions of AI tools could serve as an immediate step toward greater inclusivity. Additionally, schools and universities must collaborate with local authorities and international

partners to develop sustainable digital access plans, especially in high-risk or frontline regions.

Teacher training is equally vital – without the pedagogical know-how to integrate these tools meaningfully, their full potential will remain untapped. Workshops, mentoring programmes, and open-access instructional materials should be developed to help educators use AI not just functionally, but strategically. Equipping libraries, resource centres, and community hubs with stable internet and AI access points could also extend the reach of technology-enhanced learning. Importantly, any implementation plan must be informed by regular feedback from students and teachers to ensure responsiveness to real needs. Equity in access should be guided by principles of justice, resilience, and long-term educational reform, not temporary solutions. In doing so, we create not only a more connected educational landscape, but a more empowered and future-ready generation of Ukrainian learners.

In the context of post-crisis educational recovery, teacher preparedness is not merely an operational concern – it is a strategic imperative. Professional development must go beyond basic digital skills to encompass a nuanced understanding of AI's cognitive, ethical, and disciplinary dimensions. Educators need opportunities to explore how tools like ChatGPT, Grammarly, and Quillionz can be aligned with curricular goals, assessment frameworks, and differentiated instruction. This requires time, resources, and institutional support, particularly for teachers in under-resourced or rural schools.

Collaborative training environments – where educators can share best practices, analyse student outputs, and co-design lesson plans – can foster a culture of experimentation and reflection. Embedding AI literacy into initial teacher education programmes and continuing professional development courses would help future-proof Ukraine's teaching workforce. Importantly, training should emphasise not only what AI tools can do, but what they should do – guiding educators in identifying meaningful learning outcomes rather than simply automating routine tasks. For example, instructors might explore how Quillionz can be used to support formative

assessment, or how Grammarly's feedback can prompt student discussions on style and clarity.

Institutional leadership plays a critical role in setting the vision for such integration. Universities and ministries must develop clear policies on AI use in education, including ethical guidelines, data protection, and academic integrity protocols. Investment in localised, Ukrainian-language training materials and case studies would further enhance contextual relevance. Moreover, educators should be empowered to critically evaluate AI outputs and question their appropriateness, ensuring that technology serves pedagogy – not the other way around. Teachers must also be prepared to guide students in navigating the emotional and psychological aspects of AI use, including dependency, self-efficacy, and creative confidence.

Beyond the classroom, physical and digital infrastructure must be expanded to accommodate inclusive access to these technologies. Community centres, libraries, and even mobile units could serve as AI access points in regions affected by war or economic hardship. Partnerships with NGOs, international donors, and tech companies could provide funding, training, and infrastructure to bridge these gaps. Feedback loops must also be institutionalised – involving regular consultation with teachers and learners to evaluate how AI tools are impacting learning, motivation, and engagement.

Furthermore, strategic monitoring and evaluation mechanisms should be implemented to measure not just tool usage, but educational outcomes over time. This will ensure that investments in AI are delivering equitable and measurable benefits, particularly for vulnerable populations. Attention should also be paid to language diversity and digital inclusion, ensuring that learners who study in Ukrainian or minority languages are not disadvantaged by Anglocentric or monolingual tools. In this way, equity is not treated as an afterthought, but as a cornerstone of a digitally empowered Ukrainian education system.

Ultimately, the transformation envisioned is not just technical, but philosophical. It requires a shift from tool adoption to systemic change – one that places pedagogy, ethics, and learner empowerment at the centre. When teachers are fully supported, they become catalysts for innovation, resilience, and social cohesion. In the face of immense

challenges, they hold the capacity to not only maintain educational continuity, but to redefine it. Through robust teacher training and equitable infrastructure, we lay the groundwork for an education system that is not only stronger than before, but more just, more inclusive, and more attuned to the complex needs of a recovering nation.

In conclusion, while AI cannot repair the physical destruction of war, it can help rebuild a more resilient, adaptive and future-oriented educational system. It can empower students to think more deeply, write more clearly, and engage more fully – not despite the crisis they face, but in response to it. And it is precisely this kind of meaningful, thoughtful engagement that Ukraine’s educators must continue to cultivate, even as the world around us remains uncertain. In doing so, we not only teach English – we teach courage, reflection, and the intellectual tools of resistance.

AI, when embedded within a well-considered pedagogical framework, becomes more than a technological instrument – it becomes a companion in the learning journey, particularly in moments of national upheaval. In the face of disrupted schooling, fragmented instruction, and psychological strain, students require more than access to knowledge – they require scaffolding, encouragement, and the tools to think independently and critically. The thoughtful integration of AI into the Ukrainian educational context symbolises not an escape from adversity, but an active response to it – a way of reclaiming intellectual agency amid instability.

AI tools such as ChatGPT, Grammarly, and Quillionz, when used with intention and critical reflection, provide (*Chauncey, 2024*) students with opportunities to ask better questions, craft more precise responses, and interrogate meaning rather than simply absorb it. This cultivation of inquiry-based learning and metacognitive awareness is essential for Ukraine’s post-war academic renewal, where future engineers, scientists, and professionals must be not only technically proficient but also adaptable, thoughtful, and linguistically agile. Moreover, by embracing AI in the service of English for Specific Purposes, educators position themselves at the intersection of innovation and resilience – actively shaping a curriculum that is not paralysed by crisis but inspired by the possibilities of recovery and reinvention.

These tools can be especially empowering for students whose learning is shaped by displacement or isolation. In contexts where electricity is rationed and in-person seminars are impossible, the ability to engage asynchronously with language and content fosters a sense of progress and continuity. It restores not only academic momentum but a measure of psychological stability – reminding students that they are not frozen in wartime stasis, but still moving forward, learning, growing. Educators, too, find in these tools a renewed sense of pedagogical purpose, able to extend their reach and reimagine traditional roles as facilitators, moderators, and curators of digital learning.

Yet, we must be vigilant not to mistake automation for autonomy. Technology can augment learning, but it is the human interaction, the questioning, the dialogue between thought and language, that gives learning its transformative power. The task ahead is not to replace traditional education, but to reinforce it with tools that enable learners to adapt, to question, and to articulate their own knowledge in a language that crosses borders. Through this, AI becomes not only a method but a metaphor – a symbol of how Ukraine's educational system can be simultaneously rooted in tradition and oriented towards the future.

We must therefore cultivate critical digital literacies that are grounded in ethics, empathy, and intellectual discipline. These are the traits that will sustain Ukrainian education not just through recovery, but into a new phase of growth and global integration. In this moment of reconstruction, education has the power to restore not only knowledge, but identity, dignity, and hope. Every meaningful act of learning, every question posed, every sentence rewritten with more clarity is a quiet act of defiance against the forces that seek to silence and destabilise.

And so, in empowering our students to think, speak, and write in English with confidence and care, we prepare them not only for professional success, but for meaningful participation in the rebuilding of their country. In these seemingly small linguistic acts, there is strength. There is strategy. And there is a vision – not just for how Ukraine survives, but for how it thrives, intellectually, democratically, and globally.

References:

1. Anderson L. W., Krathwohl D. R. (2001). A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives: Complete Edition. *New York: Longman*, 352 p. URL: <https://surli.cc/xnfizl> (Accessed on: 22.07.2025).
2. Bangerl M. M., Disch L., David T., Pammer-Schindler V. (2025). CreAlTive collaboration? Users' misjudgment of AI-creativity affects their collaborative performance. *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems. Association for Computing Machinery*, Article 195. P. 1-17. DOI: <https://doi.org/10.1145/3706598.3713886>.
3. Benítez T. M. et al. (2024). Harnessing the potential of large language models in medical education: Promise and pitfalls. *Journal of the American Medical Informatics Association*. Vol. 31, № 3. P. 776-783. DOI: <https://doi.org/10.1093/jamia/ocad252>.
4. Chauncey S. A., McKenna H. P. (2024). Creativity and Innovation in Civic Spaces Supported by Cognitive Flexibility When Learning with AI Chatbots in Smart Cities. *Urban Science*. Vol. 8, № 1. Article 16. DOI: <https://doi.org/10.3390/urbansci8010016>.
5. Facione P. A. (2011). Critical thinking: What it is and why it counts. *Insight Assessment*. Vol. 1, № 1. P. 1-23. URL: <https://tinyurl.com/27mfe8lg>. (Accessed on: 20.07.2025).
6. Fredricks J. A., Blumenfeld P. C., Paris A. H. (2004). School Engagement: Potential of the Concept, State of the Evidence. *Review of Educational Research*. Vol. 74, № 1. P. 59-109. DOI: <https://doi.org/10.3102/00346543074001059>.
7. Ibrahimova L., Nykyporets S., Derun V., & Herasymenko N. (2021). Information and communication technologies as a means of teaching foreign languages in technical universities. *Proceedings of the 3rd International Scientific and Practical Conference "Scientific Trends and Trends in The Context of Globalization"*. 21-22 December 2021. Scientific Publishing Center «InterConf». P. 91-100. DOI: <https://doi.org/10.51582/interconf.21-22.12.2021.010>.
8. Kot S. O., Nykyporets S. S. (2024). Utilization of artificial intelligence in enhancing English language proficiency in tertiary education. *Science and education in the third millennium: Information technology, education, law, psychology, social sphere, management. Chap. 10. Institute of Public Administration Affairs*, P. 250–274. DOI: <https://doi.org/10.5281/zenodo.11279390>.
9. Michalon B., Camacho-Zuñiga C. (2023). ChatGPT, a brand-new tool to strengthen timeless competencies. *Frontiers in Education*. Vol. 8. Article 1251163. DOI: <https://doi.org/10.3389/feduc.2023.1251163>.
10. Miranty D., Widiati U., Yudi Cahyono B., Intan Suzila Tengku Sharif T.. (2025). La eficacia de la aplicación de Grammarly y la retroalimentación proporcionada por el docente en relación con los estudiantes de EFL en el ámbito de la escritura. *Innoeduca. International Journal of Technology and Educational Innovation*. Vol. 11, № 1. P. 108-133. DOI: <https://doi.org/10.24310/ijtei.111.2025.20521>.
11. Mittal U., Sai S., Chamola V., Sangwan D.. (2024). A comprehensive review on generative AI for education. *IEEE Access*. Vol. 12. P. 142733-142759. DOI: <https://doi.org/10.1109/ACCESS.2024.3468368>.
12. Nykyporets S. S. (2025). Artificial intelligence as a catalyst for advancing soft skills in higher technical education. *Proceedings of the 4th International Scientific and Practical Conference "Evolving Science: Theories, Discoveries and Practical Outcomes"*, 9-11 June 2025, Zurich, Switzerland. *European Open Science Space*, P. 377-388. URL: <https://ir.lib.vntu.edu.ua/handle/123456789/46733>. (Accessed on: 21.07.2025).
13. Nykyporets S. S., Melnyk O. D., Ibrahimova L. V., Boiko Y. V., Kukharchuk H. V. (2023). Fostering critical thinking in technical university students in foreign language classes: Strategies and approaches for cultivating analytical proficiency. *Bulletin of Science and Education. Series "Pedagogy"*. № 8(14). P. 344-360. DOI: [https://doi.org/10.52058/2786-6165-2023-8\(14\)-344-360](https://doi.org/10.52058/2786-6165-2023-8(14)-344-360).
14. Nykyporets S. S., Melnyk O. D., Ibrahimova L. V., Hadaichuk N. M., Derun V. H.. (2024). Advancing critical thinking skills among higher education students through English language instruction: Contemporary approaches and strategies. *Prospects and Innovations of Science. Series "Pedagogy"*. № 1(35). P. 34-45. DOI: [https://doi.org/10.52058/2786-4952-2024-1\(35\)-34-45](https://doi.org/10.52058/2786-4952-2024-1(35)-34-45).

15. Nykyporets S., Boiko Y. (2024). Practical tips and interactive learning tools for the work of a foreign language teacher at a technical university in the conditions of blended learning during the full-scale military aggression of Russia against Ukraine. *International collective monograph "World trends in the use of interactive technologies in education". Intellebence Transportation System And Smart City Institute (ITSSCI)*, DOI: <https://doi.org/10.5281/zenodo.10653715>.
16. Singh A. Taneja K., Guan Z., & Ghosh A.. (2025). Protecting human cognition in the age of AI (arXiv Preprint No. 2502.12447). *arXiv*, DOI: <https://doi.org/10.48550/arXiv.2502.12447>.
17. Staples S., Anthony L. (2023). Corpus linguistics in EFL language teaching: Insights from research and practice. *JALT Journal*. Vol. 45, № 2. P. 246-264. DOI: <https://doi.org/10.37546/JALTJJ45.2-4>.
18. Stepanova I. S., Nykyporets S. S. (2024). Determinants of resilience in English language teachers amid martial law. *Актуальні проблеми філології та методики викладання іноземних мов у сучасному мультимовному просторі: Матеріали Всеукраїнської науково-практичної конференції*, 30 жовтня 2024 р., Вінниця. Гол. ред. О. М. Ігнатова. Вінниця: ТОВ «Друк», С. 70-72. URL: <https://ir.lib.vntu.edu.ua/handle/123456789/43681> (Accessed on: 25.07.2025).
19. Yawiloeng R. (2025). Investigating EFL students' writing problems through the lens of Grammarly. *Theory and Practice in Language Studies*. Vol. 15, № 7. P. 2172-2181. DOI: <https://doi.org/10.17507/tpsls.1507.09>.
20. Yuan Y. (2024). An empirical study of the efficacy of AI chatbots for English as a foreign language learning in primary education. *Interactive Learning Environments*. Vol. 32, № 10. P. 6774-6789. DOI: <https://doi.org/10.1080/10494820.2023.2282112>.
21. Zakaria N. Y. K., Hashim H., Jamaludin K. J. (2025). Exploring the Impact of AI on Critical Thinking Development in ESL: A Systematic Literature Review. *Arab World English Journal (AWEJ). Special Issue on Artificial Intelligence*. P. 330-347. DOI: <https://dx.doi.org/10.24093/awej/AI.19>.
22. Ziar P. Q. (2025). Impact of AI-Based Tools on Writing Skills. *Journal of Research in Education*. Vol. 1, № 1. P. 97-112. DOI: <https://doi.org/10.3126/jore.v1i1.78725>.