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ARTICLE

The Use of AI Writing Tools in Second Language Learning to Enhance Kazakh IT Students' Academic Writing Skills

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ABSTRACT

In multilingual educational environments, such as those in Kazakhstan, integrating artificial intelligence (AI) into second-language teaching presents new pedagogical possibilities. This study investigates the impact of AI-powered writing tools on academic writing achievement, student engagement, and ethical awareness among second-year Information Technology (IT) students enrolled in a Russian as a second language course at the International Information Technology University (IITU). Based on Vygotsky's Zone of Proximal Development (ZPD), the study employed a mixed-methods design, incorporating pre- and post-tests, student surveys, and reflective journals. An instructional model was implemented that integrated AI tools into a scaffolded writing pedagogy. Results showed a 23% increase in essay length (fluency), a 31% reduction in language errors (accuracy), and an improvement in lexical diversity (TTR) from 0.52 to 0.64. Surveys and journals revealed that students perceived AI tools as helpful for enhancing writing clarity and revision, but also expressed concerns about their ethical use and potential over-reliance. Reflective journal analysis showed a significant increase in students' ethical awareness, with 70% demonstrating an understanding of authorship, transparency, and academic integrity

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by the end of the course. These results suggest that when thoughtfully integrated within a framework aligned with students' ZPD, AI tools can improve academic writing outcomes while supporting metacognitive and ethical development. The study offers practical implications for AI-enabled language learning in digitally-focused, multilingual university contexts.
Keywords: AI Writing Tools; Academic Writing; Russian as a Second Language; Zone of Proximal Development; Student Engagement; Ethical Awareness; IT Students; Scaffolding

1. Introduction

Contemporary education is undergoing a remarkable transformation with the development of Artificial Intelligence (AI), which has significantly reshaped the landscape of language learning and teaching (LLT), particularly in academic writing instruction[1–4]. AI-powered tools, ranging from adaptive learning platforms to intelligent feedback systems, facilitate personalized learning, real-time assessment, and immersive language practice in second language (L2) learning, including Russian as a second language (RL2). According to the Law of the Republic of Kazakhstan "On Language"[5], Russian remains the language of academic, professional, and everyday communication in the country. Its study is not only widespread among local multilinguals but is also becoming increasingly popular among international students seeking linguistic and cultural access to the region[6].

Within Kazakhstan's multilingual higher education environment, the difficulties in academic writing become especially apparent. While some Kazakh researchers argue that students now face heightened expectations to write in the L2, given their diverse linguistic backgrounds and the increasing demand for scholarly publications[7, 8], others claim that traditional writing instruction prioritizes the final product over the writing process, as learners gain a minimal understanding of genres, rhetorical devices, and critical thinking skills during LLT[9, 10].

It is generally accepted that AI-based solutions provide learners with a scalable and flexible approach to enhancing the quality of their writing, enabling them to draft, revise, and refine their written texts. These tools offer strong support for developing writing skills; however, they also raise significant concerns about authorship, originality, and academic literacy development[11]. As a result, some students might misuse AI-generated content or inadvertently engage in plagiarism, bypassing crucial steps in the learning process[12–14]. This scenario requires a more thoughtful pedagogical strategy. Based on the Global CIO's[15] call for educators to integrate AI technologies not as shortcuts but as supportive tools that promote ethical writing practices and foster student independence, recent research supports the integration of these tools, embedding explicit, teacher-led instruction that develops skills in paraphrasing, summarizing, source integration, and critical revision[12].

The Kazakh state's fundamental documents, such as the Digital Kazakhstan Program[16], the Kazakhstan 2025 Strategy[17], and the Concept of Development of Artificial Intelligence for 2024-2029[18], have significantly accelerated the digitalization of education, leading to a rethinking of LLT methodologies. However, online learning environments (OLEs) still tend to replicate traditional face-to-face teaching, failing to harness the interactive and adaptive potential of digital tools[19]. This is particularly evident in online writing teaching, where delayed instructor feedback, limited peer interaction, and lack of structured support hinder the development of academic writing skills[20]. Although platforms such as Moodle, Coursera, Canvas, and others have increased access, they often fail to provide targeted, responsive support tailored to the diverse needs of learners in multilingual contexts. These challenges underscore the need for more innovative AI-powered tools that provide personalized guidance, real-time assessment, and peer collaboration, essential components for developing practical writing skills in a digital environment. To address this gap, the present study investigates how integrating AI-driven writing tools influences the academic writing performance, engagement, and ethical awareness of Kazakhstani IT students in the RL2 course. Conducted with second-year students at the Faculty of Information Technology, IITU, the study draws upon Vygotsky's sociocultural theory and scaffolding principles to propose an instructional model that aligns AI support with academic integrity, process-based writing, and learner engagement. This study also aligns with the goals of the

Digital Kazakhstan program, which aims to integrate digital technologies into all levels of education to improve the quality and accessibility of learning[16]. Additionally, the study examines Kazakhstan's trilingual policy and the increasing demand for digital literacy in Russian as a second language of instruction, particularly among students in technical fields[21].

2. Literature Review

The advent of the Internet has redefined writing as a social and networked process, facilitated by improved collaboration and interactivity. At the same time, technological innovations, such as word processors, have transformed writing instruction by moving composition from manual to digital formats and streamlining drafting and editing methods[12, 22]. More recently, advances in natural language processing (NLP) and AI have led to the development of tools that provide real-time feedback and content improvement, promoting technical accuracy and higher-order thinking[1, 7].

AI-based applications, particularly automated writing evaluation (AWE) systems, are being used for writing instruction in educational institutions worldwide. These systems typically include two main components: automated scoring systems and automated writing correction systems (AWCS)[23]. Initially developed for standardized assessments, they are used in the context of classroom instruction to diagnose language errors and support revision[13, 22]. Despite mixed results, some studies highlight that tools like Grammarly or QuillBot improve writing accuracy and metalinguistic awareness, encouraging learners' autonomy while reducing the feedback burden on teachers[14, 24]. While AI-powered writing tools have significant instructional potential, several studies have addressed concerns regarding academic malpractice, data inaccuracies, misinformation, reduced learning, and plagiarism concerns[20–25]. Additionally, scholars caution that their uncritical use reduces writing to a mechanical task, obscuring its social, cognitive, and communicative aspects[25]. Temper, Tjoa, and David[3] advocate for pedagogical design, arguing that without an instructional framework, students rely on these tools for superficial editing, thereby bypassing essential processes such as critical thinking and self-regulation. As a constructive response, researchers emphasize that AI tools are most effective when embedded in structured, disciplined writing curricula that promote reflection and active engagement[10]. Bates advocates that successful language learning depends on "the integration of rich input, meaningful interaction, and timely feedback"[21], which AI technologies provide in a unified and responsive manner[25]. These tools promote vocabulary development by exposing users to authentic content, facilitating real-time interactions with conversational AI agents, and providing immediate feedback on language use.

Vygotsky's concept of the ZPD[26] remains fundamental in sociocultural theories of learning, particularly in contexts involving guided instruction and mediated tools (**Figure 1**). The ZPD refers to a range of tasks that a learner cannot complete independently but can accomplish with the support of a more knowledgeable other, such as a teacher, peer, or technological tool. As Vygotsky emphasized, "*learning is a social process, and the role of scaffolds in the ZPD is critical to facilitating cognitive development*"[26], p. 32. More recent scholars have expanded this view to include technological mediation; for example, Donato[27] argued that tools, both material and symbolic, play a central role in shaping mental functioning. In language education, this has led to the growing recognition of digital scaffolds, including AI-based tools, as legitimate tools for facilitating learning. These tools can provide timely feedback, model appropriate language use, and promote reflective practice, thereby acting within the learner's ZPD. However, critics warn that without proper pedagogical design, such tools risk becoming shortcuts rather than supportive scaffolds[28, 29]. Therefore, the integration of AI into writing instruction should be done with cognitive apprenticeship and supported autonomy in mind[29]. Thus, when aligned with ZPD principles, AI tools can promote higher-order thinking, metacognitive regulation, and ethical reasoning, key goals in both language learning and academic literacy development.

Building on ZPD principles, recent research advocates for the integration of AI as a facilitating agent, one that supports rather than replaces cognitive development and metacognitive awareness. Authors state that, within this perspective, AI-based writing tools are not viewed as shortcuts to improved writing outcomes, but rather as facilitating tools embedded in structured learning environments that promote gradual autonomy, deep learner engagement, and ethical aca-

demic practice[29]. This approach, grounded in Vygotsky's sociocultural theory, emphasizes the central role of socially and technologically mediated interaction in the development of higher-order thinking and linguistic competence.

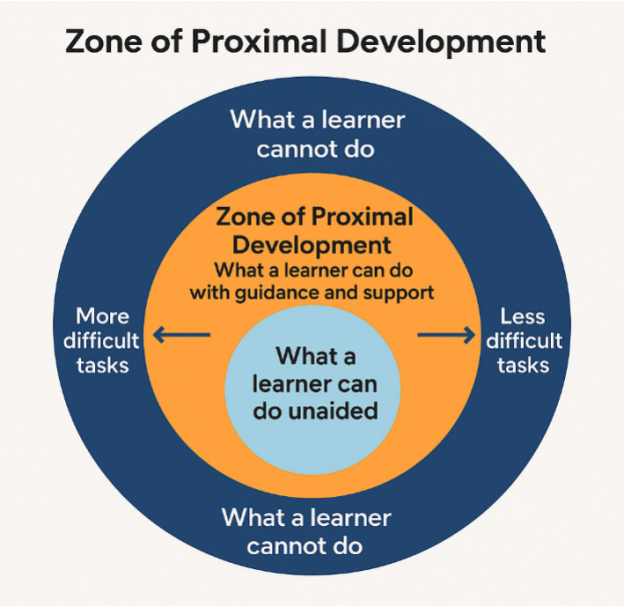

Figure 1. The Zone of Proximal Development Framework by Vygotsky.

In the context of Kazakhstan's language policy, which promotes fostering citizens' multilingual competence in Kazakh, Russian, and English, the integration of AI tools into RL2 writing instruction offers a promising pedagogical approach. Digital transformation initiatives, such as the Digital Kazakhstan strategy, further emphasize the importance of technology-based education in developing national human capital in ICT and multilingual communication in higher education. For second-year IT students, who are already digital natives accustomed to interacting with algorithmic systems, AI-enabled learning offers a natural extension of their digital habits into the domain of language learning. More importantly, such integration provides targeted opportunities to enhance writing performance, encourage sustained engagement, and develop ethical awareness in academic communication.

The following section describes the pedagogical approach and research design used to examine how AI-based writing tools impact academic writing performance, engagement, and ethical awareness of Kazakhstani IT students learning Russian as a second language.

3. Materials and Methods

3.1. ZPD-Based Instructional Model for AI-assisted Writing

This study examines the effect of integrating AI-driven writing tools on the academic writing performance, learner engagement, and ethical awareness of second-year IT students enrolled in the RL2 course at the International Information Technology University (IITU) in Kazakhstan. The research is motivated by the growing digitalization of education under national initiatives, such as the Digital Kazakhstan Program[16] and the Concept of Development of Artificial Intelligence for 2024–2029[18], as well as the lack of pedagogically grounded models for integrating AI in multilingual academic writing contexts.

To operationalize the integration of AI into instructional design, the study draws on a range of AI-supported language learning platforms and writing assistance tools. **Table 1** provides an overview of selected AI-based platforms and tools that support RL2 learners, both within Kazakhstan's multilingual education system and among international students. These platforms address key linguistic challenges, such as complex case morphology, aspectual distinctions, and syntax, while also providing conversational practice and feedback generation. These tools were chosen for their capacity to align with the scaffolding principles of the pedagogical model and their accessibility to the student population.

These tools were integrated at various stages of the writing process, including brainstorming, drafting, peer review, revision, and final reflection, to scaffold learners' development within their individual ZPD. The instructional sequence and tool usage were carefully aligned with the study's research question and pedagogical goals.

Academic writing, particularly in a second language, requires both technical accuracy and the development of critical and ethical engagement with the writing process. However, peer collaboration, dialogic feedback, and process-oriented writing are often underemphasized in digital instruction[30, 31]. Although AI tools are widely used in academic contexts globally, their educational integration in multilingual language learning environments remains underresearched in Kazakhstan. This integration is grounded in Vygotsky's sociocultural theory, particularly the concept of the ZPD, which posits that learning occurs most effec-

tively when students receive scaffolded support to complete tasks just beyond their current ability. Within this perspective, tools both human and technological act as mediational means that enable learners to internalize higher-order thinking processes through interaction within their ZPD, providing real-time linguistic scaffolding, promoting engagement through interactive feedback, and encouraging ethical writing through metacognitive reflection [26]. **Figure 2** summarizes how specific pedagogical goals in language learning, particularly in the development of academic writing, can be supported by AI tools within a scaffolded and developmentally aligned instructional approach. Rooted in Vygotsky's sociocultural theory, this approach underscores the centrality of socially and technologically mediated interaction in the development of higher-order thinking and linguistic competence.

Table 1. AI Language Learning Tools Supporting Russian as an L2: Learning and Teaching.

Tool	Key Features	Platform
Memrise (https://www.memrise.com)	GPT MemBot, spaced repetition, and multimedia content	Web, iOS, Android
SpeakPal (https://www.speakpal.ai)	AI tutors, immersive dialogues, personalized paths	Web, Mobile
Gliglish (https://gliglish.com)	AI conversations, role-playing scenarios	Web
Talkpal (https://talkpal.ai)	Conversational AI with a user-friendly interface	Web
Lingopie (https://lingopie.com)	Dual subtitles, flashcards, and media immersion	Web, Mobile, TV
iVoca (https://ivoca.io)	Speech recognition, Russian video practice	Android, iOS, Web
LangBuddy (LangBuddy)	Personalized conversation AI for RL2	Web
LanguageTool (https://languagetool.org)	Grammar, spelling, and style checker (Russian included)	Web, Browser Add-ons
Orfogrammka (https://orfogrammka.ru)	Grammar and stylistic improvement for Russian	Web
Glvrd (https://glvrd.ru)	Russian text clarity and readability checker	Web
QuillBot (https://quillbot.com)	Russian text paraphraser, grammarchecker, plagiarism checker, summarizer	Android, iOS, Web

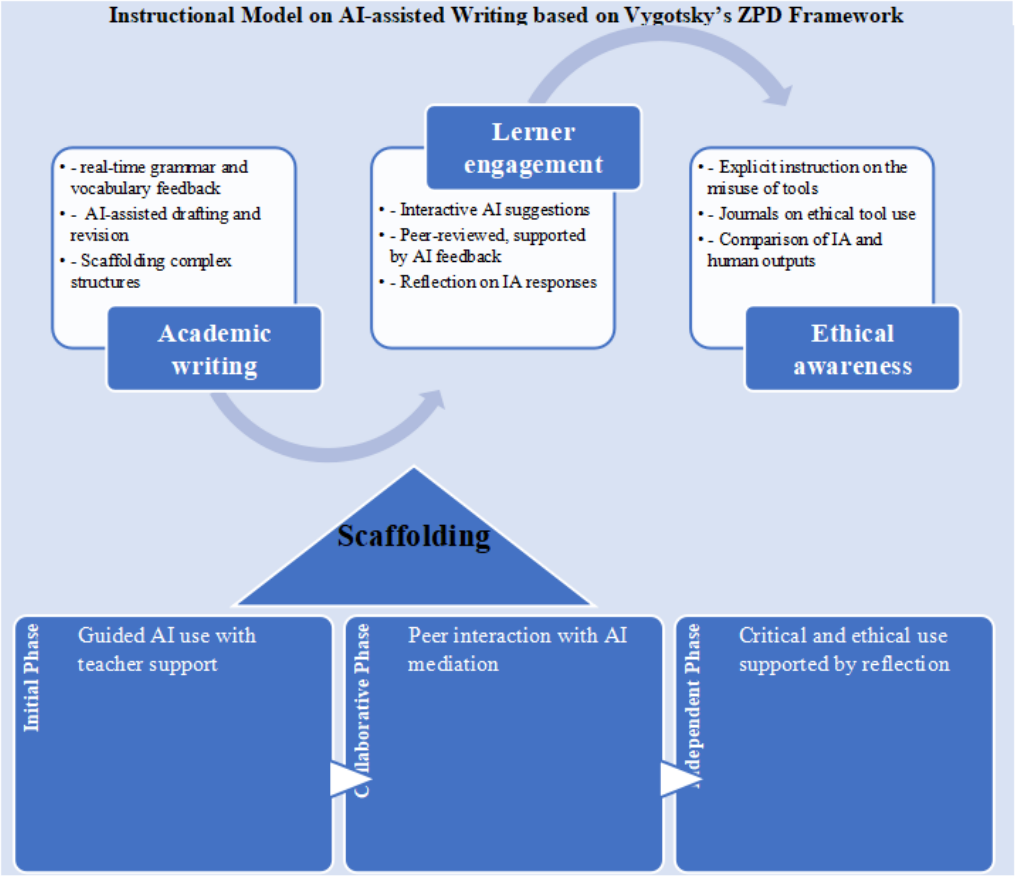

Figure 2. Instructional Model aligned with Vygotsky's ZPD Framework.

Figure 2 illustrates that the introduction of AI tools into L2 writing instruction should not be viewed solely as a technological enhancement, but rather as a pedagogical intervention grounded in sociocultural learning theory. For Vygotsky, "*effective learning occurs within the learner's ZPD, where support from more capable others, including tools, peers, or instructors, enables the acquisition of skills beyond the learner's current independent capabilities*"[26]. In this study, instructional support was strategically designed to align with this theoretical orientation and gradually shift responsibility from the teacher and AI tools to the learner, enhancing their academic writing skills, engagement, and ethical awareness. With adequate instructional support, learners can quickly proofread their texts while also immersing themselves in the feedback to gain a deeper understanding and enhance their learning. In the context of RL2, language is characterized by complex morphological and syntactic systems that extend beyond the sentence level to the discourse level. This form of support is especially beneficial for non-native speakers.

Learner engagement is essential for sustained writing development. AI-enabled platforms support the creation of interactive, personalized, and iterative writing experiences that align with Vygotsky's view of learning as socially mediated[32]. Students interact not only with AI-generated feedback but also with peers and instructors, using suggestions as discussion topics in collaborative revision activities. As Song and Song[33] show, students are more engaged when they are encouraged to reflect on and justify their responses to AI feedback. Such reflective interaction positions the learner as an active participant rather than a passive recipient, thereby facilitating deeper engagement in the writing process. As students become more experienced users of AI writing assistance, there is a risk that they bypass critical thinking and rely on tools for superficial editing without fully understanding the underlying linguistic rules[34]. To counter this, the pedagogical design includes metacognitive support, encouraging students to critically evaluate the appropriateness of AI suggestion, reflect on the ethical implications of tool use, and engage in explicit instruction on responsible digital authorship[33]. This is consistent with Chang and Chou[35], who argue that digital literacy in writing instruction should include not only tool navigation but also ethical and rhetorical judgment. In our study, the framework was structured into three sequential stages: (1) an initial stage, where students interacted with AI tools under teacher guidance to gain basic grammatical and vocabulary support; (2) a collaborative stage, where AI feedback was integrated with peer review and group revision tasks; and (3) an independent stage, where students were encouraged to critically evaluate AI-generated suggestions and reflect on their writing processes and ethical considerations. This gradual approach is consistent with Wood, Bruner, and Ross's[32] conceptualization of scaffolding as a temporary support that is gradually withdrawn as learners gain autonomy.

The improvements in learners' fluency, accuracy, and lexical diversity in the post-test writing samples support the effectiveness of this scaffolding model. Moreover, journal reflections and survey results indicate that scaffolding not only supported language development but also promoted metacognitive awareness and ethical reasoning. These results are consistent with Donato's[27] view of instructional scaffolding as a cognitive and social process in second language learning.

Importantly, the AI tools did not serve as a substitute for instruction, but rather as facilitators[36], thus facilitating the collaborative construction of knowledge. When used in scaffolding tasks, the AI feedback became a prompt for collaborative dialogue and reflection rather than a passive correction. This positioning of AI tools helped to preserve the social and interactive nature of writing development.

Overall, the integration of AI tools into a scaffolding instructional framework has proven pedagogically sound, enhancing both writing proficiency and learner autonomy. As digital tools become increasingly embedded in academic writing, instructional models based on ZPD and scaffolding will be essential to ensure not only skill development but also ethical and critical engagement with AI technologies.

To operationalize the theoretical framework grounded in Vygotsky's ZPD concept, the present study implements a structured instructional model that integrates AI-driven writing tools across the academic writing process. While the previous section addressed the rationale for using AI to scaffold linguistic and cognitive development, a critical element of the methodology is the design of a sequenced ZPD-based instructional model that reflects learners' developmental readiness, promotes interaction, and supports ethical writing behavior.

Vygotsky's ZPD emphasizes that learning is most ef-

fective when learners engage in tasks they cannot complete alone but accomplish with guided support. This principle underpins the model's phased structure, in which AI tools are introduced as mediational agents that support, but do not replace, learners' efforts at each stage of the writing process. The model also positions the teacher and peers as co-mediators, gradually fading their support as learners develop autonomy (**Table 2**). Thus, the ZPD-based instructional model for AI-assisted writing is a structured, ethically grounded pedagogical framework that utilizes AI tools as support agents to facilitate learners' gradual transition from guided to independent academic writing, in line with Vygotsky's sociocultural theory, positioning teachers and peers as co-facilitators.

Table 2. ZPD-based Instructional Model Phases to Align AI to the Teaching Writing Process.

	Phase	Instructional Focus	AI Integration	ZPD Function
Teacher and Peers as Co-Mediators	Pre-writing	brainstorming, vocabulary activation	concept maps, semantic tools (e.g., Memrise)	Expand the topic range and language beyond current capabilities.
	Drafting	sentence construction, initial structuring	grammar/style tools (e.g., QuillBot, Orfogrammka)	Provide mechanical scaffolds to free cognitive resources.
	Peer Review	collaborative feedback and revision	peer review with AI prompts (e.g., LanguageTool suggestions)	Mediate writing improvement through guided social interaction.
	Revision	rewriting, coherence, and clarity	revision logs, AI + human feedback integration	Scaffold metacognitive revision strategies.
	Reflection	ethical writing awareness	journals, tool-use analysis, AI vs. human feedback comparison	Promote academic integrity and responsible use of tools.

This model was designed with the recognition that digital-native learners, such as Kazakhstani IT students, are often proficient in using AI tools but lack instructional guidance on how to use them ethically and reflectively. Without such support, students rely on AI to edit at a surface level, without engaging with the deeper linguistic and rhetorical challenges of academic writing [29]. The instructional model directly addresses this by pairing tool use with structured peer interaction, teacher feedback, and explicit ethical scaffolding, which are supported by AI tools as shown in **Table 1**.

Moreover, while many digital learning environments emphasize access and efficiency, they often underutilize the collaborative and reflective aspects of writing [30, 31]. This model counteracts that trend by embedding peer and teacher mediation alongside AI interaction, ensuring that learning remains dialogic and socially situated.

The integration of reflective writing journals and portfolio-based assessments further supports metacognitive awareness and academic integrity, helping students internalize not only how to write but also how to critically evaluate the role of AI in their writing development [36]. Regarding the RL2 writing instruction, the following tools were used to support each phase of the model:

- LanguageTool, Orfogrammka, Glvrd for automated feedback on mechanics and style;
- Google Docs + comments, peer review rubrics for structured peer collaboration;
- Reflective Journals + Portfolio Checklists for ethical and developmental assessment;
- Talkpal, Lingopie, and Memrise for pre-task enrichment and vocabulary support.

These tools were selected for their accessibility, support for Russian language input, and alignment with the ZPD-aligned instructional phases.

Instructional tasks in this model are defined as structured, goal-oriented learning activities that integrate AI support and social interaction to scaffold learner development within their ZPD. Each task is designed to target a specific writing phase, combining automated assistance with peer or teacher mediation to foster academic writing skills, reflective thinking, and ethical awareness. Examples of instructional tasks for each phase are given in **Table 3**.

Table 3. Instructional Tasks Examples.

Phase & Aim		Objective	Example Task Instruction	Teacher Support	ZPD Function
Pre-Writing	Activating Ideas and Planning	Expand topic awareness and activate prior knowledge through AI-mediated brainstorming.	Open a concept-mapping tool (e.g., MindMeister or Memrise's AI-based word associations). Enter your essay topic (e.g., 'Cybersecurity in Kazakhstan'). Use the tool to generate related keywords and concepts in Russian. Choose five terms you did not know before and write one sentence for each. Then, outline three main ideas you want to cover in your essay.	Offer language prompts and translation clarification	AI helps students access vocabulary and topic associations beyond their current level
Drafting	Constructing Paragraphs with AI Support	Produce a first draft using AI tools for grammar and vocabulary support	Write the introduction paragraph of your essay. Use AI tools to revise your grammar, punctuation, and sentence flow. After running your draft through the tool, copy the before-and-after versions into your portfolio. Highlight one change the AI suggested that you disagree with, and explain why.	Provide mini-lessons on sentence structures and connectors	Students complete writing that exceeds their unaided grammatical competence with the aid of AI mediation.
Peer Review	Collaborative Improvement	Engage in peer dialogue using AI feedback as a springboard	Exchange your draft with a classmate. Use the comments generated by LanguageTool as starting points for your peer feedback. Add two comments of your own: (1) one related to content development (e.g., argument strength), and (2) one about clarity or tone. Use this sentence frame: 'The AI suggested ____, but I also think you could ____.	Provide peer review templates and sentence starters	Learners build competence through social interaction and supported evaluation
Revision	Deepening Content and Structure	Critically evaluate and revise content based on peer and AI feedback	Revise your complete draft based on both AI and peer feedback. Focus on improving transitions, coherence, and argument development. Use a revision log to track the following: (1) what you changed, (2) who/what prompted the change (AI, peer, teacher), and (3) your reasoning.	Offer targeted feedback on coherence and logic development	Students engage in metacognitive processes—deciding when and how to revise with support
Reflection	Ethical Awareness and Self-Assessment	Develop responsible AI use and authorship awareness	Write a 200-word journal entry reflecting on how you used AI tools in this assignment. Discuss which AI suggestions you accepted or rejected and why. Then, answer: Do you feel this essay is still your work? How do you define ethical writing when using digital tools?	Facilitate group discussions on AI ethics and originality	Scaffold students' ethical awareness and academic self-concept through guided reflection

This instructional model is central to the methodology, as it ensures that the three core constructs examined, writing performance, learner engagement, and ethical awareness, are not only measured but actively developed through pedagogy. The model transforms AI from a static resource into an interactive pedagogical tool that aligns with learners' cognitive, social, and ethical development trajectories.

In doing so, the study contributes not only empirical findings but also a replicable framework for integrating AI in multilingual writing instruction in under-researched educational contexts, such as Kazakhstan.

3.2. Participants and Tools

Participants included 54 second-year IT students at IITU. All students demonstrated intermediate proficiency in the Russian language. The tools used included LanguageTool, Orfogrammka, Glvrd, Google Docs, and Reflective Journal templates. Tool selection was based on their support for Russian, accessibility, and alignment with the instructional phases.

3.3. Data Collection and Analysis

Data sources included student writing samples, revision logs, peer review comments, and reflective journals. Quantitative data on writing performance (fluency, accuracy, complexity) were collected pre- and post-intervention. Qualitative data were analyzed for evidence of metacognitive engagement and ethical reasoning.

This methodology section outlines a research design that not only examines the effect of AI integration but does so within a theoretically informed, pedagogically coherent instructional framework, grounded in the ZPD and adapted to Kazakhstan's multilingual educational context.

Analysis of pre- and post-intervention writing samples revealed statistically significant improvements in three key dimensions of academic writing: fluency, accuracy, and lexical diversity. These results are based on a comparison of students' performance on initial diagnostic essays and final course essays submitted after completing the AI-enabled learning cycle.

To assess the impact of AI-based tools on students' writing performance, three quantitative measures based on standard research on second language writing were used:

- *Fluency* is measured by the average number of words per essay assessing the productivity of writing and ease of expression, where....

$$Fluency = \frac{Total\ Words\ Written}{Number\ of\ Essays}$$

- *Accuracy* is measured by the error rate, which is calculated as the percentage of errors relative to the total number of words written; a lower percentage indicates greater grammatical accuracy, where...

$$Error\ Rate = \frac{Total\ Errors}{Total\ Words} \times 100$$

- *Lexical Diversity* or Type–token Ratio (TTR), reflects the diversity of a vocabulary by comparing unique word forms (types) to the total number of words (tokens), where...

$$TTR = \frac{Number\ of\ Unique\ Words}{Total\ Number\ of\ Words}$$

Percentage change is used to quantify progress from pre-test to post-test across all measures:

$$Percentage\ Change = \frac{Post\ Test\ -\ Post\ Test}{Pre\ Test} \times 100$$

These metrics are based on second language acquisition research suggested by Wolfe-Quintero et al.[37] and Yuan and Ellis[38] and are particularly suitable for short-term writing interventions. Fluency reflects how AI tools reduce the cognitive load on lower-order problems. Accuracy is consistent with real-time grammar and syntax support from tools such as Grammarly and Orfogrammka. Lexical diversity, although sensitive to text length, provides insight into vocabulary development stimulated by AI suggestions and language modeling.

4. Results

To assess the impact of AI-based writing tools on students' academic writing performance, a pre- and post-intervention test writing task was administered. Participants were asked to write argumentative essays on one of the suggested topics (**Table A1**) for 60 minutes both before and after the instructional intervention. The topics for the pre- and post-tests were consistent in genre (argumentative essay), relevance to students' discipline (IT), and cognitive demands. This consistency ensured that the writing samples could be compared across different stages, supporting the study's internal validity and the research goal of assessing AI's impact on academic writing development. Additionally, we maintained the same genre, structure, and task type (argumentative essay) for the pre- and post-test phases to isolate the impact of integrating AI tools on students' writing development. By avoiding differences in task design, we ensured that any observed improvements in fluency, accuracy, and lexical diversity could be attributed to the instructional intervention rather than to differences in task demands. This design choice is consistent with best practices in experimental writing research, where controlling for task type enhances internal validity[38]. The writing tasks were completed under time control and using the same digital platform to ensure consistency. **Table 4** presents a comparison of pre- and post-test results across three key measures: fluency, accuracy, and lexical diversity. **Table 4** demonstrates that students' fluency, as measured by the average word count per essay, rose by 23%, from 312 to 384 words per essay. This implies that students gained confidence in expressing their ideas with the aid of AI tools. Regarding accuracy, the error rate fell by 31%, and accuracy scores improved from 87.6% to 91.5%.

Frequently corrected mistakes included noun-adjective agreement and punctuation, which the AI tools successfully identified and corrected. Furthermore, lexical diversity (TTR) increased from 0.52 to 0.64. This enhancement indicates that students expanded their vocabulary range, likely influenced by AI-generated synonyms and collocation suggestions.

Table 4. Post-Test Writing Performance Results.

#	Indicator	Pre-Test	Post-Test	Improvements
1	Fluency (words/essay)	312.0	384.0	+23.08
2	Accuracy (%)	87.6	91.5	+4.45
3	Lexical Diversity (TTR)	0.52	0.64	+23.08

Teacher ratings indicated similar improvements in argument structure, logical flow, and genre appropriateness. These results highlight that AI tools effectively support learning according to Vygotsky's ZPD, enabling students to progress beyond their independent capabilities. This illustrates measurable improvements in writing performance, supporting the conclusion that AI-based tools had a positive impact on students' academic writing in a ZPD-aligned learning model.

To further understand how participating IT students perceived the integration of AI writing tools in their Russian as a Second Language course, we adapted and contextualized items from earlier research on online writing satisfaction. A post-treatment survey measured students' engagement and perceptions of AI-supported writing instruction. The three-point Likert scale ranged from 1 (agree) to 2 (neutral) to 3 (disagree). Three PhD and two Master's expert reviewers validated the survey. **Table 5** presents and interprets students' responses to a Likert scale survey examining the impact of AI-based writing tools on writing productivity, engagement, and ethical awareness. The results reflect a range of perspectives, with notable trends in motivation, confidence, and process management modelling based on modern educational tools [39].

Table 5. Students' Perception of AI-assisted Writing Instruction.

#	Statements	Mean in %		
		Agree	Neutral	Disagree
1.	AI feedback helps me improve the clarity and structure of my academic writing.	51	34	16
2.	I am more motivated to revise my writing when using AI tools like Grammarly or LanguageTool.	59	18	23
3.	Using AI tools supports my understanding of grammar and vocabulary in Russian.	36	28	36
4.	AI-generated suggestions encourage me to think critically about my writing choices.	43	9	48
5.	I understand the ethical boundaries of using AI tools in academic writing tasks.	37	11	52
6.	I feel more confident expressing my ideas in Russian after using AI writing tools.	65	13	22
7.	AI tools help me manage my writing process more effectively (e.g., planning, editing, revising).	58	15	27

In response to Question 1, just over half of the students (51%) agreed that AI feedback improved the clarity and structure of their academic writing. This supports previous research suggesting that AI tools serve as a scaffold, particularly at the micro level of writing [35]. A significant 34% remained neutral, indicating potential variability in tool use or guidance. For Question 2, the majority (59%) reported increased motivation to revise when using AI tools, demonstrating their potential to encourage engagement through immediate and actionable feedback. Only 23% disagreed, indicating that most students find revision more accessible when supported by technology. For grammar and vocabulary support (Question 3), opinions were evenly divided on whether AI tools supported grammatical and lexical understanding (36% agree vs. 36% disagree). This suggests that without explicit metalinguistic guidance or mediation from the teacher, students may not fully benefit from the corrective feedback offered by AI platforms. In terms of critical thinking (Question 4), respondents showed polarized views, with 43% agreeing and 48% disagreeing that AI suggestions facilitate crucial engagement. This raises concerns that students rely too heavily on automated suggestions without reflection, highlighting the need for structured support and ethical training [13]. Regarding Question 5, the majority

(52%) reported a lack of clarity regarding the ethical use of AI, with only 37% being confident in these boundaries. This highlights a critical gap in training and is consistent with concerns in the literature about the unregulated use of tools that can lead to academic misconduct [40]. Regarding Question 6 on confidence in expression, the highest agreement (65%) was observed among students who felt more confident in expressing ideas in Russian after using the AI tools. This result is significant in the context of RL2, where writing anxiety and lexical uncertainty are common [41]. Regarding the management process (Question 7), the majority (58%) agreed that the AI tools helped them manage their writing more effectively, especially in the planning, editing, and revising stages.

These results support the role of AI tools as facilitators in the language learning process, aligning with the facilitating principles of the ZPD. The data suggest that students generally perceive the integration of AI as a support mechanism that improves both their academic writing skills and self-efficacy (statements 1 and 2). However, lingering concerns regarding ethical awareness and responsible use of the tools (statements 5 and 7) highlight the need for intentional pedagogical support.

To address these concerns, reflective journal responses (see **Appendix B**) were analyzed to assess the development of students' ethical reasoning. **Table 6** reports that at the beginning of the course, only 19% of students were able to identify potential risks such as overreliance on AI tools or blurred authorship. By the end of the learning intervention, 70% of students demonstrated increased awareness of academic integrity, authorship transparency, and responsible digital practices. Journal entries frequently referenced class discussions and reflective prompts, confirming the effectiveness of metacognitive support. While 21% of students felt that the AI improved their writing without diminishing their ownership, a larger group (47%) reported a tension between the convenience of automated suggestions and the authenticity of their writing. This diversity of reflections signals the emergence of critical digital literacy and ethical judgment, key outcomes targeted by the ZPD-aligned learning framework as indicators ofthe effectiveness of learners' feedback information [42].

Table 6. Reflective Journal Findings.

	Aspect	Percentage
1	Identified AI-related ethical risks by the course start	19
2	Identified AI-related ethical risks by the course end	70
3	Cited classroom prompts/discussion in journal	63
4	Felt AI supports writing without compromising the ownership	21
5	Reported tension between AI use and authenticity	47

The quantitative and qualitative results of this study demonstrate that the integration of AI-powered writing tools can significantly improve the academic performance, engagement, and ethical awareness of Kazakhstani IT students enrolled in the RL2 course. As evidenced by the post-test results, students demonstrated measurable growth in all three performance metrics. Fluency, rising from 312 to 384 words, suggests that students became more confident in extended written expression with the support of AI tools such as Grammarly and Orfogrammka. Accuracy metrics also improved from 87.6% to 91.5%, most evident in grammatical features such as noun-adjective agreement and punctuation, areas that the AI tools successfully targeted. Lexical diversity improved from 0.52 to 0.64, indicating an expanded vocabulary and diversity likely driven by AI-generated synonyms and collocation suggestions. The survey results further confirm the positive impact of AI integration. More than half of the students (51%) agreed that AI feedback improved the clarity and structure of their writing, and 59% agreed that AI tools increased their motivation to revise their work. However, the responses also revealed challenges: only 37% reported understanding the ethical boundaries of using AI tools, and 48% expressed concerns about the lack of critical thinking encouraged by automated suggestions. These findings were further expanded through an analysis of students' reflective journals, which showed that while initially only 19% could articulate concerns about authorship and over-dependence, by the end of the course, 70% demonstrated awareness of key ethical issues, including transparency, authorship, and academic integrity. This shift is consistent with the ZPD, in

which structured mediation and reflective practice support the internalization of complex competencies such as ethical reasoning [43]. These findings underscore the importance of adopting a pedagogically informed approach to integrating AI that is grounded in sociocultural theories of learning. Specifically, instructional design should position AI not as a replacement for learning, but as a framework that supports learners' transition to greater autonomy and metacognitive control.

5. Discussion

This study aimed to investigate the impact of AI-based writing tools on students' academic writing performance, engagement, and ethical awareness in the context of learning RL2 among Kazakhstani IT students.

Regarding academic writing performance, the quantitative pre- and post-test comparisons demonstrated clear improvements in fluency, accuracy, and lexical diversity. Using tools such as Orfogrammka and QuillBot helped students produce longer texts with fewer grammatical errors and a wider range of vocabulary. Teachers' evaluations also showed improvements in structural coherence, argument quality, and genre awareness. These results support the claim that AI tools integrated through structured instructional design act as cognitive scaffolds, enabling students to perform tasks beyond their current abilities—an application of Vygotsky's Zone of Proximal Development (ZPD). However, it was noted that without explicit guidance, students were likely to use AI primarily for superficial editing rather than higher-order revision.

Concerninglearners engagement, the survey data reflected increased engagement in writing assignments that incorporated AI tools. Students expressed greater confidence in revising their work, valued the immediacy of feedback, and found writing with AI support more motivating. However, responses were mixed regarding sustained focus and collaboration with peers. These results suggest that AI feedback should be integrated into socially interactive practices, such as peer review, guided revision, and teacher conferencing, to maintain the conversational nature of learning and maximize engagement. The ZPD-based instructional model achieved this by integrating AI assistance with writing preparation phases and structured feedback loops.

For ethical awareness, the analysis of reflective journals revealed that students' understanding of academic ethics had undergone significant change. By the end of the course, 70% of students were able to articulate core principles of academic integrity, transparency, and authorship. Explicit reflection prompts and ethics-focused activities were effective in helping students distinguish between the supportive use of AI and the outsourcing of intellectual work. However, some students continued to express uncertainty about authorship, indicating that ethical reasoning in the context of digital writing remains an emerging competency. This highlights the need for sustained metacognitive support and clear institutional guidance.

These insights suggest that the effective integration of AI tools serves as an empowering scaffold, particularly for IT students. These findings support the role of AI as a cognitive and affective support mechanism that promotes learner autonomy and engagement, aligning with the concepts of Kazakh scholars on utilizing new technologies in educational organizations [44]. Furthermore, the results indicate that without guided instructional design, students primarily use AI tools for surface-level corrections, thereby bypassing higher-order language processing and critical thinking. In terms of ethical awareness, the reflective journal analysis showed a positive correlation with transparency, originality, and academic integrity. This shift highlights the effectiveness of metacognitive support strategies in developing digital ethics and responsible tool use. However, approximately half of the students continued to express concerns about the tension between the usability and authenticity of AI, suggesting that ethical reasoning in digital contexts remains an evolving competency [36, 45]. The survey results allow us to offer the following recommendations:

- AI tools should be introduced in gradual phases that align with students' ZPD. Initial instruction should emphasize structured feedback on grammar and vocabulary, followed by peer-reviewed collaborative writing sessions, and culminate in independent writing that is supported by the selective use of AI.
- Explicit instruction and reflective activities, such as reflective journals, should be used to build students' ethical awareness. These assignments help students critically evaluate the implications of using AI tools and

develop a sense of responsible authorship.

- Encourage students to use AI suggestions for synonyms, collocations, and syntactic variations. Teachers should facilitate guided activities that allow students to compare AI suggestions with their original text, thereby promoting lexical and grammatical development.
- AI tools should complement, not replace, teacher and peer feedback. Structured opportunities to discuss AI feedback preserve the social and dialogic nature of writing instruction.
- Assignments that require students to justify or revise their text in response to AI feedback enhance critical thinking and interaction. These interactions can be embedded in class discussions or collaborative revision workshops.
- Institutional policies and classroom norms should clearly define acceptable and unacceptable uses of AI in academic writing, reinforcing the values of originality, transparency, and academic integrity.
- Both students and teachers benefit from targeted training sessions on how to use AI tools effectively and ethically. Such training should cover functional use, critical interpretation of feedback, and responsible digital authorship.

Taken together, these recommendations advocate for a balanced and pedagogically sound approach to AI integration that considers the cognitive, affective, and ethical aspects of language learning in multilingual contexts. Furthermore, by adopting these recommendations, educators can contribute to a more supportive and motivating AI-based language learning environment by addressing the strengths and challenges identified in the survey.

Future research should explore skill retention and adapt the model to other disciplines and language settings.

The findings validate the instructional model's focus on writing performance, engagement, and ethical development. The progressive design, AI support, peer mediation, and ethical reflection proved pedagogically effective. Students' ability to explain their revisions confirms the success of the ZPD-based scaffolding approach.

This study confirms that integrating AI writing tools into a structured, interaction-rich, and ethically grounded curriculum enhances academic writing instruction in multilingual contexts, such as Kazakhstan.

6. Conclusions

This study investigated the impact of integrating AI-based writing tools on academic writing performance, learner engagement, and ethical awareness among Kazakh IT students enrolled in the RL2 course. Grounded in Vygotsky's sociocultural theory and the concept of the ZPD, the study demonstrated that when AI tools are used as facilitators within a structured instructional framework, they significantly enhance the learning process. Quantitative results showed notable improvements in fluency, accuracy, and lexical diversity, confirming that the ZPD-based Instructional Model for AI-assisted Writing effectively supports language development by addressing lower-level linguistic concerns. This assistance allowed learners to refocus their cognitive efforts on higher-order writing processes, such as constructing and organizing arguments. Qualitative analysis based on student surveys and reflective journals indicated increased engagement and a growing awareness of metacognitive and ethical considerations. Students expressed greater confidence in their written work, a deeper understanding of authorship responsibilities, and an appreciation for the supportive, yet non-substitutive, role of AI technology in their learning. The study supports a ZPD-aligned, phase-based instructional model that combines AI feedback with peer collaboration, instructor guidance, and reflective practice. By integrating AI-based writing tools into multilingual writing instruction, this model not only supports learner engagement and autonomy but also contributes to national education strategies emphasizing digital innovation and multilingual proficiency, especially regarding Russian as a second language and the development of professional academic literacy in technical disciplines[46]. The results offer actionable ideas for implementing technology-enhanced language instruction in line with government priorities.

As Kazakhstan continues to develop its digital and multilingual educational landscape, this study offers timely insights into the responsible and pedagogical integration of AI into language education, providing practical implications for AI-enabled language learning in digitally focused, multilingual university contexts[47]. This is particularly vital for promoting ethical awareness, critical thinking, and autonomy, especially in emerging knowledge societies such as Kazakhstan. Future work could extend this model across disciplines and examine its long-term impact on students'

academic and professional writing skills.

Author Contributions

Conceptualization, R.S., Z.S., P.Y., A.M., A.S., A.K.; methodology, R.S., Z.S., P.Y., A.M., A.S., A.K.; software, R.S., Z.S., P.Y., A.M., A.S., A.K.; validation, R.S., A.M., A.S., and A.K.; formal analysis, R.S., A.M., A.S., A.K.; investigation, R.S., A.M., A.S., A.K.; resources, R.S., A.M., A.S., A.K.; data curation, R.S., A.M., A.S., A.K.; writing—original draft preparation, R.S., Z.S., and P.Y.; writing—review and editing, R.S., Z.S., and P.Y.; visualization, R.S., Z.S.; supervision, Z.S.; project administration, R.S., Z.S.; funding acquisition, R.S., Z.S., P.Y., A.M., A.S., A.K. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

Appendix A

Table A1. Argumentative Essay Topics for IT students.

Pre-Test	Post-Test
1. Should high school students be required to learn coding? 2. Is online education more effective than traditional classroom learning? 3. Should social media be restricted for students during the school year? 4. Does technology enhance or weaken human communication? 5. Should students use AI tools, such as translators or grammar checkers, for school assignments? 6. Is it better to specialize in one programming language or learn several? 7. Should internet access be considered a fundamental human rights?	1. Should AI tools be allowed in academic writing? 2. Can AI ever replace human teachers in IT education? 3. Does the use of AI in education help or harm student learning? 4. Should developers be held accountable for the ethical use of their AI applications? 5. Is it ethical to use AI-generated content without proper attribution? 6. Should governments regulate the use of AI in education and employment? 7. Is AI development a threat to human employment in the tech industry?

Appendix B

Reflective Journal Questions on ZPD-based model for AI-assisted Academic Writing

Instructions: As part of the reflective component of this study, please respond to the following prompts after completing your final academic writing assignment. Your reflections will help assess your evolving understanding of AI-enabled writing, particularly in relation to academic integrity and the ethical use of tools.

1. AI Tool Use: Which AI writing tools (e.g., Orfogrammka, ChatGPT, QuillBot)

- *Did you use this for this assignment?*
- *At what stages of the writing process did you use them (e.g., idea generation, drafting, editing, reviewing)?*
- *Which features did you find most useful (e.g., grammar check, vocabulary suggestions, content feedback)?*

2. Decision Making and Authorial Review
   - *Which AI-generated suggestions did you accept or reject?*
   - *What reasons did you give for accepting or rejecting these suggestions?*
   - *In your opinion, who is the author of the final version — you, the AI tool, or both? Please explain.*
3. Writing learning and development
   - *What have you learned about academic writing by interacting with AI tools?*
   - *How have these tools helped you improve clarity, structure, or accuracy?*
   - *Were there any moments when you felt confused, overly dependent, or unsure of the AI feedback?*
4. Ethical Reflection and Academic Integrity. How do you define ethical writing when using AI tools?
   - *Do you feel that the final text reflects your academic voice and effort? Why or why not?*
   - *What are the risks of over-reliance on AI in academic writing (e.g., plagiarism, loss of originality, confusion about authorship)?*
   - *How would you explain the difference between having your writing supported by AI and outsourcing your work to AI?*
5. Future Practice and Peer Recommendations:
   - *If you had to do a similar writing assignment again, how would you change your approach to using AI tools?*
   - *What recommendations would you give to other students on using AI so that it is ethical, practical, and meets academic expectations?*

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