

BRIDGING LANGUAGE AND MATHEMATICS THROUGH ARTIFICIAL INTELLIGENCE: PREDICTING MATHEMATICAL REASONING FROM ENGLISH LANGUAGE COMPETENCE AMONG BS CRIMINOLOGY STUDENTS

GEROME B. AVILA

Zamboanga State College of Marine Sciences and Technology

Zamboanga City, Philippines

Abstract

Artificial intelligence (AI) is gradually revolutionizing the instruction of the English language, but little empirical evidence exists on its application to discipline-specific English for Specific Purposes, especially among criminology students. This study aimed to explore the impact of AI-assisted English language education on the English learning achievement, second language (L2) motivation, self-regulated learning, and professional communication preparedness of Bachelor of Science in Criminology students using mixed methods. The study was designed as a pretest-posttest nonequivalent control group and compared students taking a 10-week AI-assisted English for Criminology Purposes intervention with their peers who received conventional teacher-led education. Quantitative results showed that the AI-assisted group had significantly higher gains in English learning achievement than the comparison group, and students also reported high levels of L2 motivation, self-regulated learning, and professional communication readiness after the intervention. Qualitative studies demonstrated that AI provided personalized, instant, and interactive learning support to enhance grammar, vocabulary, writing, comprehension, and professional communication and foster learner autonomy, reflection, and motivation. The findings also indicate that AI-supported language instruction can connect English language competency with discipline-specific communication needs and may facilitate the development of analytical and reasoning skills necessary to criminology education. However, competent AI use needs critical appraisal of the material produced by AI, academic honesty, ethical use, and ongoing teacher guidance. Overall, AI-assisted English for Criminology Purposes was promising as a supplementary technique to promote language competence, autonomous learning, readiness for professional communication and other academic skills of future criminology professionals.

Keywords: mathematical reasoning, artificial intelligence, English for Specific Purposes, English for Criminology Purposes, language learning achievement, L2 motivation, self-regulated learning

Introduction

Background of the Study

The advent of the Fourth Industrial Revolution (4IR) has fundamentally transformed higher education through the rapid integration of artificial intelligence (AI), reshaping traditional

instructional paradigms into adaptive, data-driven, and learner-centered educational ecosystems (Chen et al., 2020; Hwang et al., 2020). As one of the defining technological innovations of the digital age, AI extends beyond conventional educational technologies by employing machine learning, natural language processing, predictive analytics, and intelligent automation to facilitate personalized instruction, adaptive assessment, and evidence-based educational decision-making (Roll & Wylie, 2016; Ouyang & Jiao, 2021). Consequently, higher education institutions worldwide have increasingly integrated AI-powered instructional platforms, intelligent tutoring systems, automated feedback mechanisms, and generative AI applications into classroom instruction to enhance learning effectiveness and prepare graduates for digitally driven professional environments (Ilkka, 2018; Kim et al., 2019; Chen et al., 2022). This educational transformation underscores the growing imperative to develop learners who are technologically proficient, autonomous, and capable of lifelong learning within increasingly complex global knowledge economies.

Within the Philippine higher education system, the integration of AI in teaching and learning presents significant opportunities, particularly in English language education. Although English serves as one of the country's official languages and the primary medium of instruction in higher education, the Philippines remains an English as a Second Language (ESL) context where learners demonstrate varying levels of language proficiency influenced by their linguistic backgrounds, regional dialects, socioeconomic conditions, and educational experiences. For many Filipino students, English functions primarily as an academic and professional language rather than the language of everyday communication. Consequently, learners frequently encounter persistent challenges in grammar, academic writing, vocabulary development, oral communication, critical reading, and discipline-specific language use despite years of formal English instruction. These challenges become increasingly evident at the tertiary level, where students are expected to employ English in complex academic discourse and professional communication.

The situation is particularly pronounced among Bachelor of Science in Criminology students. As future law enforcement officers, investigators, forensic practitioners, correctional administrators, and criminal justice professionals, criminology students are expected to communicate with precision, objectivity, and professionalism using English across a wide range of occupational contexts. Their future responsibilities require competence in investigative report writing, police blotter documentation, affidavit preparation, forensic documentation, intelligence reporting, legal correspondence, courtroom communication, incident reporting, witness interviewing, and interagency coordination. These communicative tasks demand not only grammatical accuracy but also mastery of technical terminology, legal discourse conventions, analytical writing, and formal professional communication.

Despite the professional significance of English proficiency, many BS Criminology students continue to struggle with the linguistic competencies necessary for effective academic performance and future professional practice. As ESL learners, they frequently encounter difficulties in constructing grammatically accurate sentences, organizing coherent written

reports, applying discipline-specific vocabulary, interpreting legal and forensic texts, expressing ideas confidently during oral communication, and producing objective professional documentation. These language-related challenges become even more significant considering the increasing internationalization of criminal justice systems, transnational crime prevention initiatives, cybercrime investigations, and multinational law enforcement cooperation, all of which require professionals capable of communicating effectively in English within multicultural and multilingual environments.

Previous needs assessment studies conducted among BS Criminology students have consistently identified substantial learning needs in English grammar, vocabulary, academic writing, oral communication, reading comprehension, and English for Specific Purposes (ESP), particularly within professional criminology contexts. These findings indicate that traditional English instruction alone may be insufficient to address the specialized communicative demands required in contemporary criminal justice practice. Instead, there is an increasing need for innovative instructional approaches capable of providing individualized, contextualized, and profession-oriented language learning experiences that respond directly to the identified English language needs of criminology learners.

Within this context, artificial intelligence has emerged as a promising pedagogical innovation capable of transforming English language instruction for ESL learners. The convergence of AI and language education has facilitated the transition from teacher-centered instruction toward adaptive, interactive, and learner-responsive environments that promote individualized language acquisition and authentic communicative engagement (Ahmadi, 2018; Shadiev & Yang, 2020; Rahimi & Fathi, 2022). Contemporary AI-powered applications such as ChatGPT, Grammarly, Duolingo, QuillBot, and Microsoft Copilot provide learners with intelligent grammar correction, contextual vocabulary enhancement, automated writing evaluation, conversational simulations, pronunciation support, and real-time formative feedback that extend learning beyond the classroom. Rather than replacing instructors, these technologies function as cognitive scaffolds that supplement instruction, encourage learner autonomy, and facilitate continuous language development through personalized learning pathways.

A growing body of empirical evidence further substantiates the effectiveness of AI-assisted English language instruction. Previous investigations have consistently demonstrated that AI-enhanced learning environments significantly improve learners' grammatical competence, vocabulary acquisition, reading comprehension, writing proficiency, speaking performance, learning motivation, and self-regulated learning through adaptive instruction and immediate feedback (Xu et al., 2022; Hsu et al., 2023; Kim, 2019; Junaidi, 2020; Yan, 2023; Ebadi & Amini, 2022; Ali et al., 2023). Nevertheless, these investigations have been conducted predominantly within general English as a Foreign Language (EFL) contexts, with limited attention devoted to English as a Second Language learners enrolled in discipline-specific programs such as criminology.

Although the literature consistently supports the pedagogical effectiveness of AI-assisted language learning, no known empirical investigation has comprehensively examined its effectiveness among Filipino BS Criminology students learning English as a Second Language while simultaneously evaluating its influence on English learning achievement, second language (L2) motivation, self-regulated learning, and professional communication readiness within English for Criminology Purposes. More importantly, existing research has rarely integrated previously identified English language needs with AI-based instructional interventions, leaving a significant gap between diagnosing learners' linguistic deficiencies and implementing evidence-based instructional innovations capable of addressing those deficiencies.

Against this backdrop, the present study examines the effectiveness of Artificial Intelligence-assisted English language instruction among Filipino BS Criminology students learning English as a Second Language. Building upon previously identified English language needs, the study investigates whether AI-mediated instruction enhances English learning achievement, strengthens second language motivation, fosters self-regulated learning behaviors, and develops professional communication readiness within the context of English for Criminology Purposes. In doing so, the study contributes to the growing body of scholarship on technology-enhanced English for Specific Purposes, provides empirical evidence for AI-supported curriculum innovation in criminology education, and offers practical insights into preparing future Filipino criminal justice professionals for increasingly digital, multilingual, and globally interconnected professional environments.

Bridging language and mathematics through Artificial Intelligence (AI) represents an emerging interdisciplinary approach to understanding how linguistic competence may support students' development of mathematical reasoning. Among BS Criminology students, proficiency in English is particularly relevant because mathematical concepts, problems, instructions, and quantitative information are often communicated through language. Difficulties in comprehending mathematical terminology and problem statements may consequently affect students' ability to analyze information, apply appropriate strategies, and arrive at logical solutions. With the increasing integration of AI-driven learning technologies in education, opportunities have emerged to strengthen language and mathematical learning through personalized, interactive, and adaptive support. Thus, this study, "Bridging Language and Mathematics through Artificial Intelligence: Predicting Mathematical Reasoning from English Language Competence among BS Criminology Students," seeks to examine the potential of English language competence as a meaningful predictor of mathematical reasoning, while highlighting the role of AI in connecting language learning with mathematics education.

General Objective

To determine the effectiveness of Artificial Intelligence-assisted English language instruction in enhancing the English learning achievement, second language motivation, self-regulated

learning, and professional communication readiness of Bachelor of Science in Criminology students.

Specifically, this study aims to:

1. Determine the effectiveness of AI-assisted English language instruction in improving the English learning achievement of BS Criminology students.
2. Determine the effectiveness of AI-assisted English language instruction in enhancing the second language (L2) motivation of BS Criminology students.
3. Determine the effectiveness of AI-assisted English language instruction in strengthening the self-regulated learning of BS Criminology students.
4. What theoretical perspectives explain the relationship between language competence and mathematical reasoning?

Review Of Related Literature

Artificial Intelligence in Higher Education and Language Instruction

Artificial intelligence has emerged as one of the most transformative innovations shaping contemporary higher education, fundamentally redefining instructional delivery, learner engagement, and knowledge construction. The increasing sophistication of machine learning algorithms, natural language processing, adaptive analytics, and intelligent tutoring systems has enabled educational institutions to transition from standardized instructional models toward personalized learning environments that accommodate individual learner characteristics, cognitive abilities, and academic needs. Unlike conventional educational technologies that merely digitize instructional materials, AI-powered systems continuously analyze learner performance, identify knowledge gaps, predict learning trajectories, and provide individualized recommendations that optimize academic achievement and instructional effectiveness (Chen et al., 2020; Hwang et al., 2020).

Within language education, AI has demonstrated exceptional potential for enhancing both instructional quality and learner outcomes. Recent developments in AI-assisted language learning have introduced intelligent conversational agents, automated writing evaluation systems, speech recognition technologies, adaptive vocabulary applications, grammar correction tools, and virtual learning environments capable of providing immediate formative feedback and individualized instructional support. These technologies facilitate interactive learning experiences that encourage learners to actively construct linguistic knowledge while simultaneously reducing dependence on teacher-centered instruction (Ahmadi, 2018; Shadiev & Yang, 2020; Rahimi & Fathi, 2022). As emphasized in recent literature, AI-assisted instructional environments create opportunities for learners to engage in personalized, communicative, and adaptive language learning experiences that substantially improve language acquisition and learner engagement.

The educational significance of AI extends beyond technological innovation because intelligent instructional systems increasingly function as cognitive partners that support

higher-order thinking, autonomous learning, and reflective practice. Contemporary AI platforms such as ChatGPT, Grammarly, Microsoft Copilot, QuillBot, and Duolingo provide learners with context-sensitive feedback, alternative linguistic expressions, grammar refinement, vocabulary enhancement, and conversational simulations that closely approximate authentic communication. Rather than replacing instructors, these technologies augment pedagogical practices by facilitating continuous learning opportunities inside and outside formal classroom settings. Such developments position AI as an instructional innovation capable of supporting learner-centered education while simultaneously promoting digital literacy and lifelong learning competencies demanded in twenty-first-century professional environments.

Artificial Intelligence-Assisted English Language Learning

The integration of AI into English language instruction has generated substantial scholarly interest due to its capacity to improve both linguistic competence and overall learning experiences. AI-mediated instructional systems capitalize on adaptive algorithms that continuously monitor learner progress and dynamically modify instructional content according to individual performance. Such adaptive mechanisms enable learners to receive immediate corrective feedback, personalized practice activities, and scaffolded instruction that addresses individual strengths and weaknesses more efficiently than traditional classroom approaches (Xu et al., 2022).

Previous investigations consistently report that AI-assisted instruction contributes positively to learners' overall English achievement across multiple language domains. Meta-analytic evidence indicates that AI produces significant improvements in learning achievement compared with conventional instructional approaches, particularly in vocabulary acquisition, grammar development, writing quality, reading comprehension, and oral communication. AI-supported learning environments enhance language performance by providing individualized practice opportunities, continuous formative assessment, and immediate feedback that facilitate meaningful learning experiences and sustained learner engagement.

ChatGPT and other generative AI platforms have further expanded opportunities for English language instruction by enabling learners to interact with intelligent conversational systems capable of generating coherent responses, explaining grammatical concepts, suggesting alternative sentence structures, and facilitating authentic written communication. Studies indicate that these AI-powered applications improve learners' writing quality, grammatical accuracy, vocabulary richness, and reading comprehension while encouraging greater learner confidence and participation in language learning activities (Fitria, 2023; Yan, 2023; Kohnke et al., 2023). Likewise, AI-powered applications employing speech recognition and adaptive language exercises have demonstrated measurable improvements in learners' speaking proficiency, pronunciation, and interactive communication skills through repeated guided practice and immediate feedback.

Artificial Intelligence and English Learning Achievement

English learning achievement remains one of the primary indicators used to evaluate instructional effectiveness within language education. Achievement encompasses learners' mastery of grammatical competence, vocabulary knowledge, reading comprehension, writing proficiency, and communicative performance. AI-assisted instructional systems enhance English achievement through adaptive instructional sequencing, intelligent assessment, personalized learning pathways, and continuous formative feedback that facilitate incremental language development.

Empirical evidence overwhelmingly supports the effectiveness of AI-assisted language instruction in improving English achievement. Xu et al. (2022) reported that AI-powered instructional systems significantly enhanced learners' overall English performance compared with traditional instructional approaches. Similarly, Hsu et al. (2023) demonstrated that learners exposed to AI-assisted vocabulary instruction significantly outperformed their peers in vocabulary acquisition and retention. Kim (2019) likewise found that AI-supported grammar instruction produced significantly higher grammatical competence than conventional classroom instruction. Additional investigations involving AI-supported writing instruction revealed notable improvements in coherence, grammatical accuracy, organization, and writing fluency, while AI-assisted speaking applications contributed to greater oral fluency, pronunciation accuracy, and communicative competence. Collectively, these findings suggest that AI-assisted language instruction substantially improves multiple dimensions of English learning achievement through individualized and adaptive instructional support.

Artificial Intelligence and Second Language (L2) Motivation

Second language motivation constitutes one of the most influential psychological variables affecting learners' persistence, engagement, and success in language acquisition. Contemporary motivational theories conceptualize L2 motivation as a dynamic construct influenced by learners' beliefs, attitudes, self-confidence, perceived competence, and anticipated future use of the target language. AI-assisted instructional environments strengthen motivational dispositions by creating personalized learning experiences characterized by autonomy, immediate reinforcement, meaningful interaction, and continuous feedback.

Several empirical studies demonstrate that AI-mediated language instruction positively influences learners' motivation. Ebadi and Amini (2022) reported that AI-assisted language learning significantly enhanced learners' motivation and classroom engagement through interactive instructional activities and personalized support. Similarly, Carpio Cañada et al. (2015) found that AI-enhanced language instruction increased learners' enthusiasm toward language learning, which subsequently translated into higher academic achievement. Ali et al. (2023) likewise observed that ChatGPT positively influenced learners' motivation, particularly in writing and reading activities where immediate feedback and individualized guidance enhanced learners' confidence and willingness to engage in language tasks. These

findings collectively indicate that AI promotes motivational development by satisfying learners' needs for competence, autonomy, and meaningful learning experiences, thereby fostering sustained engagement in second language acquisition.

Artificial Intelligence and Self-Regulated Learning

Self-regulated learning (SRL) has become increasingly recognized as an essential component of successful language acquisition because it enables learners to assume active responsibility for planning, monitoring, evaluating, and regulating their own learning processes. SRL encompasses cognitive, metacognitive, motivational, and behavioral strategies that facilitate independent learning and continuous academic improvement.

AI-assisted instructional systems naturally support self-regulation because intelligent technologies provide learners with real-time performance analytics, personalized recommendations, adaptive learning pathways, and immediate feedback that encourage continuous self-monitoring and reflective learning. Hsu et al. (2023) found that learners utilizing AI-assisted language learning technologies demonstrated improved self-regulatory behaviors alongside enhanced vocabulary acquisition. Adaptive AI environments encourage learners to establish learning goals, monitor their progress, identify weaknesses, and modify learning strategies according to individualized performance data. Such capabilities align closely with contemporary theories of self-regulated learning that emphasize learner autonomy, self-monitoring, and reflective practice as prerequisites for lifelong learning and academic success.

Theoretical Framework

The present investigation is situated within an integrated theoretical framework that synthesizes Vygotsky's Sociocultural Theory (Vygotsky, 1978). Rather than functioning as independent explanatory perspectives, these theories are conceptually integrated to explain the multifaceted mechanisms through which artificial intelligence (AI)-assisted English language instruction facilitates discipline-specific language learning among Bachelor of Science in Criminology students. This theoretical integration reflects the inherently interdisciplinary nature of AI-mediated education, recognizing that language acquisition within technology-enhanced learning environments emerges through the interaction of cognitive mediation, learner autonomy, motivational processes, and technology acceptance.

At the center of the framework lies Vygotsky's Sociocultural Theory, which provides the principal explanatory lens for understanding AI as an intelligent mediational artifact that extends learners' cognitive capabilities through adaptive instructional scaffolding. Vygotsky (1978) contends that higher-order cognitive development occurs through mediated interaction within the Zone of Proximal Development (ZPD), where learners accomplish increasingly complex tasks with appropriate instructional support before internalizing newly acquired competencies. Within the present study, AI-powered instructional applications function as dynamic scaffolding mechanisms that continuously adapt instructional support according to learners' linguistic performance, providing immediate feedback, contextual explanations,

guided practice, and personalized learning pathways. Such adaptive mediation enables criminology students to progressively develop specialized communicative competencies required for investigative documentation, police reporting, forensic communication, courtroom discourse, and other professional genres characteristic of English for Criminology Purposes. The empirical literature similarly characterizes AI-assisted language learning environments as adaptive, personalized, and learner-centered systems capable of enhancing language achievement through continuous instructional support.

Methodology

Research Design

The present investigation employed a mixed-methods quasi-experimental research design utilizing a pretest-posttest nonequivalent control group design to examine the effectiveness of Artificial Intelligence (AI)-assisted English language instruction in enhancing English learning achievement, second language (L2) motivation, self-regulated learning, and professional communication readiness among Bachelor of Science in Criminology students. This methodological approach was adapted from the experimental framework employed in the reference study on AI-mediated language instruction, which integrated quantitative and qualitative procedures to comprehensively evaluate the pedagogical effects of AI-assisted learning environments.

A mixed-methods approach was selected because the complexity of AI-assisted language learning extends beyond measurable improvements in academic performance and encompasses learners' cognitive, motivational, behavioral, and experiential dimensions. The quantitative component determined the extent to which AI-assisted English instruction produced statistically significant improvements in English learning achievement, L2 motivation, self-regulated learning, and professional communication readiness. Conversely, the qualitative component explored participants' lived experiences, perceptions, challenges, and instructional interactions with AI-assisted learning technologies, thereby providing deeper explanations for the quantitative findings. The integration of both strands enabled methodological triangulation and generated a comprehensive understanding of how AI-mediated instruction influenced discipline-specific English learning within the context of English for Criminology Purposes (ECP).

Specifically, the quantitative phase adopted a pretest-posttest nonequivalent control group design, wherein one group received AI-assisted English instruction while another group received conventional teacher-led instruction covering identical learning competencies and instructional duration. Both groups completed equivalent pretest and posttest assessments to determine changes in English learning achievement, L2 motivation, self-regulated learning, and professional communication readiness following the intervention. This design permitted the comparison of learning gains attributable to AI-assisted instruction while controlling for baseline differences in participants' initial language proficiency and motivational characteristics.

Following the quantitative phase, qualitative data were collected through semi-structured interviews involving purposively selected participants from the experimental group. The interviews examined learners' experiences using AI-powered instructional applications, perceptions regarding personalized feedback, autonomous learning, professional language development, motivational changes, and the perceived applicability of AI-assisted instruction to criminology-related communication tasks. The qualitative findings were subsequently integrated with the quantitative results during interpretation to strengthen the validity, credibility, and explanatory power of the investigation through methodological triangulation.

The intervention itself was specifically contextualized for English for Criminology Purposes (ECP) rather than General English instruction. AI-assisted learning activities were designed around authentic criminology communication tasks, including police blotter writing, incident and investigation reports, forensic documentation, witness interview simulations, courtroom discourse, intelligence briefings, legal correspondence, and technical vocabulary development. AI applications such as ChatGPT, Grammarly, Microsoft Copilot, and other institutionally approved language-learning technologies functioned as intelligent instructional scaffolds by providing immediate feedback, contextual language explanations, vocabulary enhancement, grammar correction, writing assistance, and conversational practice aligned with the communicative demands of criminal justice professions. This contextualization ensured that the intervention directly addressed the English language needs previously identified among BS Criminology students while maintaining fidelity to the methodological rigor of the adapted experimental framework.

Research Participants

The participants of the study consisted of fourth-year Bachelor of Science in Criminology students enrolled at Nuevo Zamboanga College, Inc. during the Academic Year 2025–2026 (or indicate the correct academic year). Fourth-year students were intentionally selected through purposive sampling because they had completed the majority of the criminology curriculum, including core professional courses requiring extensive academic writing, investigative documentation, police communication, legal correspondence, forensic reporting, and other discipline-specific communication competencies. Consequently, these students possessed sufficient academic maturity and professional exposure to meaningfully engage in English for Criminology Purposes and evaluate the educational value of AI-assisted language instruction.

Following participant recruitment and informed consent, eligible students were assigned to either the experimental group or the comparison group, depending on the existing class sections designated by the College. Consistent with the quasi-experimental design, intact classes were maintained to preserve the natural classroom environment and avoid disrupting institutional academic scheduling. One class received AI-assisted English language instruction integrated into English for Criminology Purposes, while the comparison class received conventional instructor-led English instruction using existing instructional materials

and pedagogical approaches. Both groups studied identical learning outcomes, instructional competencies, and assessment content throughout the intervention period.

Students who withdrew from the intervention, demonstrated prolonged absenteeism, or failed to complete both pretest and posttest assessments were excluded from the final statistical analyses to preserve internal validity.

For the qualitative phase, a purposive sample of participants from the experimental group was selected to participate in semi-structured interviews. Selection considered variation in academic performance, gender, AI engagement, and observed learning outcomes to ensure diverse perspectives regarding the implementation of AI-assisted English instruction. These interviews provided rich descriptions of learners' experiences, perceptions, motivational changes, self-regulatory behaviors, and perceived improvements in professional English communication, thereby complementing the quantitative findings and strengthening the overall interpretive validity of the study through methodological triangulation.

Research Instruments

Four standardized instruments and one researcher-developed instrument were employed to comprehensively measure the principal constructs investigated in the study. The selection of instruments was guided by the methodological framework adopted from the reference study while incorporating discipline-specific measures appropriate for English for Criminology Purposes.

English Learning Achievement Test

English learning achievement was measured using a researcher-developed achievement examination modeled after the comprehensive English achievement assessment utilized in the reference study. The instrument consisted of five competency domains: grammar, vocabulary, reading comprehension, professional writing, and English for Criminology Purposes communication. Unlike conventional English achievement tests, the present instrument incorporated authentic criminology-related communication tasks, including police incident reports, investigative narratives, forensic terminology, legal correspondence, and courtroom communication scenarios. The assessment was designed according to the learning outcomes prescribed for English for Criminology Purposes and evaluated participants' ability to apply English language competencies within professional criminal justice contexts.

L2 Motivation Scale

Learners' second language motivation was measured using the 16-item L2 Motivation Scale developed by Mehdiyev et al. (2017), which was likewise employed in the reference study. The instrument measures three dimensions of language learning motivation: attitude, self-confidence, and personal use using a five-point Likert scale ranging from strongly disagree to strongly agree. Minor contextual modifications were introduced to reflect the professional learning environment of BS Criminology students while preserving the conceptual integrity of the original instrument.

Self-Regulated Learning Questionnaire

Students' autonomous learning behaviors were assessed using the Self-Regulation Questionnaire (SRQ) originally developed by Brown et al. (1999) and adopted in the reference study. The instrument consists of 63 items representing seven dimensions of self-regulation, including planning, self-monitoring, evaluation, strategy implementation, behavioral control, goal orientation, and reflective learning. Responses were measured using a five-point Likert scale, with higher scores indicating stronger self-regulated learning behaviors. The SRQ was selected because of its extensive application in educational research and its demonstrated reliability across technology-enhanced learning environments.

Result And Discussion**Table 1. Pretest and Posttest English Learning Achievement Scores of the Experimental and Comparison Groups**

Group	N	Pretest Mean	SD	Posttest Mean	SD	Mean Gain
Experimental (AI-Assisted)	32	69.84	6.12	115.44	4.70	45.59
Comparison (Conventional)	41	70.05	5.39	95.83	6.12	25.78

Table 2 Paired-Samples t-test on English Learning Achievement

Group	t	p-value	Interpretation
Experimental	80.56	< .001	Significant Improvement
Comparison	65.63	< .001	Significant Improvement

Table 3 Independent Samples t-test of Posttest Scores

Comparison	Mean Difference	t	p-value	Interpretation
Experimental vs. Comparison	19.61	15.48	< .001	Significant Difference

Table 1 presents the effect of AI-assisted English language instruction on the English learning achievement of BS Criminology students. The findings indicate that both the experimental and comparison groups demonstrated comparable levels of English language

proficiency prior to the implementation of the instructional intervention. The experimental group obtained a pretest mean of 69.84 (SD = 6.12), while the comparison group recorded a pretest mean of 70.05 (SD = 5.39). These findings suggest that the two groups possessed relatively equivalent English learning achievement at baseline, thereby providing a comparable foundation for evaluating the effectiveness of the instructional approaches employed.

Following the implementation of the intervention, the experimental group obtained a substantially higher posttest mean of 115.44 (SD = 4.70) compared with the comparison group's posttest mean of 95.83 (SD = 6.12). Likewise, the experimental group registered a mean gain of 45.59 points, considerably exceeding the 25.78-point gain obtained by the comparison group. These findings indicate that students exposed to AI-assisted English language instruction demonstrated markedly greater improvement in English learning achievement than those who received conventional classroom instruction.

Within-group analyses further revealed that both instructional approaches significantly enhanced students' English learning achievement. However, the magnitude of improvement was considerably greater among respondents who participated in AI-assisted English language instruction. This finding was further substantiated by the statistically significant posttest difference between the two groups, with a mean difference of 19.61 ($t = 15.48$, $p < .001$). The obtained results provide compelling evidence that AI-assisted English language instruction was significantly more effective than conventional teaching in improving the English language proficiency of BS Criminology students.

The superior performance demonstrated by the experimental group may be attributed to the capacity of AI-assisted English language instruction to provide immediate feedback, personalized learning support, adaptive instructional guidance, and continuous opportunities for practice. These instructional affordances appear to have enabled learners to actively monitor their progress, refine their language performance, and address learning difficulties in a timely manner. Consequently, AI-assisted instruction functioned as a pedagogical scaffold that complemented classroom teaching by fostering active learner engagement, independent learning, and continuous language development. Within the context of English for Criminology Purposes, the integration of AI likewise appears to have strengthened students' competencies in grammar, vocabulary, reading comprehension, and professional writing, thereby demonstrating its effectiveness as an instructional innovation that supports discipline-specific English language learning and enhances overall academic achievement.

Table 2. Effect of AI-Assisted English Language Instruction on the L2 Motivation of BS Criminology Students (n = 418)

L2 Motivation Dimension	Mean	SD	Verbal Interpretation
Personal and Professional Use of English	4.36	0.49	Very High Motivation
Attitude Toward Learning English	4.31	0.53	Very High Motivation

English Self-Confidence	4.15	0.58	High Motivation
Overall Mean	4.28	0.47	Very High Motivation
Legend			
Mean Range	Interpretation		
4.21–5.00	Very High Motivation		
3.41–4.20	High Motivation		
2.61–3.40	Moderate Motivation		
1.81–2.60	Low Motivation		
1.00–1.80	Very Low Motivation		

Table 2 presents the level of second language (L2) motivation of BS Criminology students following their participation in AI-assisted English language instruction. The findings revealed an overall composite mean of **4.28 (SD = 0.47)**, interpreted as **Very High Second Language Motivation**. This indicates that the respondents consistently demonstrated strong motivation toward learning English and recognized its significance in both their academic pursuits and future professional responsibilities. The findings further suggest that AI-assisted English language instruction fostered positive motivational dispositions by encouraging meaningful engagement, sustained interest, and appreciation of English language learning within the context of criminology education.

Among the three motivational dimensions, **Personal and Professional Use of English** obtained the highest mean (**M = 4.36, SD = 0.49**), interpreted as **Very High Second Language Motivation**. This finding indicates that the respondents strongly perceived English as an essential competency for their future profession and acknowledged its practical value in performing communication tasks within the field of criminology and criminal justice. The integration of AI-assisted English language instruction appears to have strengthened students' awareness of the relevance of English in authentic professional contexts, thereby reinforcing their commitment to continuously improving their language proficiency.

Similarly, **Attitude Toward Learning English** attained a **Very High Second Language Motivation** level (**M = 4.31, SD = 0.53**), reflecting the respondents' positive disposition toward learning English through AI-assisted instructional activities. The findings suggest that the interactive, accessible, and personalized features of AI-assisted instruction enhanced students' enjoyment of the learning process, encouraged active participation, and sustained their interest in acquiring English language skills. By providing immediate feedback, individualized learning support, and opportunities for repeated practice, AI-assisted

instruction appears to have cultivated a more engaging and learner-centered educational experience.

Meanwhile, **English Self-Confidence** recorded the lowest mean ($M = 4.15$, $SD = 0.58$), although it likewise remained within the **Very High Second Language Motivation** category. This finding indicates that while the respondents generally possessed confidence in using English for academic and professional purposes, certain aspects of language use, particularly those requiring spontaneous communication and oral language production, remained comparatively more challenging. Nevertheless, the obtained mean demonstrates that the participants perceived themselves as capable English language learners whose confidence had been positively reinforced through continuous interaction with AI-assisted instructional tools.

Table 3. Level of Self-Regulated Learning of BS Criminology Students after AI-Assisted English Language Instruction (n = 417)

Self-Regulated Dimension	Learning Mean	Interpretation
Planning	4.37	Very High Self-Regulated Learning Behavior
Self-Monitoring	4.25	Very High Self-Regulated Learning Behavior
Evaluation	4.30	Very High Self-Regulated Learning Behavior
Strategy Implementation	4.35	Very High Self-Regulated Learning Behavior
Behavioral Control	4.19	High Self-Regulated Learning Behavior
Goal Orientation	4.42	Very High Self-Regulated Learning Behavior
Reflective Learning	4.31	Very High Self-Regulated Learning Behavior
Composite Mean	4.31	Very High Self-Regulated Learning Behavior

[Legend

Mean Range	Interpretation
4.21–5.00	Very High Self-Regulated Learning Behavior
3.41–4.20	High Self-Regulated Learning Behavior
2.61–3.40	Moderate Self-Regulated Learning Behavior
1.81–2.60	Low Self-Regulated Learning Behavior
1.00–1.80	Very Low Self-Regulated Learning Behavior

Table 3 presents the level of self-regulated learning of BS Criminology students following their participation in AI-assisted English language instruction. The findings revealed an overall composite mean of **4.31**, interpreted as **Very High Self-Regulated Learning Behavior**. This indicates that the respondents consistently demonstrated the capacity to independently regulate and manage their cognitive, metacognitive, motivational, and behavioral learning processes throughout the instructional intervention. The findings further suggest that AI-assisted English language instruction served as a pedagogical scaffold that strengthened learner autonomy by encouraging independent decision-making, strategic learning, and sustained engagement in academic tasks.

Among the seven dimensions, **Goal Orientation** obtained the highest mean ($M = 4.42$), interpreted as **Very High Self-Regulated Learning Behavior**. This finding indicates that the respondents possessed clear academic and professional aspirations that directed their learning behaviors and motivated them to achieve their educational goals. The integration of AI-assisted English language instruction appears to have reinforced students' appreciation of English language proficiency as an indispensable competency in criminology, thereby strengthening their intrinsic motivation, perseverance, and commitment toward both academic achievement and future professional preparedness.

The **Planning** dimension likewise attained a **Very High Self-Regulated Learning Behavior** level ($M = 4.37$), reflecting the respondents' consistent ability to establish learning objectives, organize instructional resources, prioritize academic responsibilities, and allocate sufficient time for learning activities. AI-assisted instruction appears to have facilitated systematic learning management by providing immediate access to instructional support, structured explanations, and adaptive learning resources that enabled students to prepare more effectively for academic tasks and learning requirements.

Similarly, **Strategy Implementation** ($M = 4.35$), **Reflective Learning** ($M = 4.31$), and **Evaluation** ($M = 4.30$) all achieved **Very High Self-Regulated Learning Behavior**. These findings imply that the respondents effectively employed appropriate learning strategies, critically reflected upon their academic performance, and continuously evaluated their progress to improve subsequent learning outcomes. The adaptive and interactive features of AI-assisted English language instruction likely strengthened students' metacognitive regulation by providing immediate feedback, personalized guidance, and repeated opportunities for practice, thereby fostering reflective thinking, strategic learning, and continuous self-improvement.

The **Self-Monitoring** dimension likewise obtained a **Very High Self-Regulated Learning Behavior** interpretation ($M = 4.25$), suggesting that the respondents consistently monitored their understanding, assessed their learning progress, and implemented corrective measures whenever learning difficulties were encountered. This finding demonstrates the capacity of AI-assisted learning environments to cultivate continuous self-assessment by enabling learners to recognize knowledge gaps, regulate their learning behaviors, and utilize available instructional resources to facilitate meaningful academic improvement.

Conversely, **Behavioral Control** recorded the lowest mean ($M = 4.19$), although it remained within the **High Self-Regulated Learning Behavior** category. This result indicates that while the respondents generally maintained discipline, managed distractions, and demonstrated persistence in completing academic requirements, certain aspects of behavioral regulation, such as sustaining motivation and minimizing procrastination, remained comparatively more challenging. Nevertheless, the relatively high mean suggests that the participants consistently exhibited positive self-regulatory behaviors throughout the implementation of AI-assisted English language instruction, further demonstrating the instructional approach's contribution to fostering autonomous, reflective, and responsible learners.

On the Theoretical Perspectives that Explains the Relationship Between Language Competence and Mathematical Reasoning

The relationship between language competence and mathematical reasoning can first be explained through the medium-function perspective, which views language as a tool for communicating, representing, storing, and retrieving mathematical knowledge. From this approach, language is used by learners to comprehend mathematical ideas, to interpret problem statements, to organize knowledge, and to communicate solution strategies. Language competency thus aids mathematical thinking. Learners must understand the verbal information to be able to recognize the necessary mathematical relations and to use the proper reasoning procedures. This perspective is supported by empirical evidence: a major meta-analysis showed a moderate association between language and mathematics, with the magnitude of the relationship increasing as mathematical tasks and language demands became more complicated. Further, language and mathematics were found to be mutually predictive throughout time (Peng et al., 2020).

Conclusion

This study concludes that Artificial Intelligence (AI)-assisted English language instruction is an effective and pedagogically sound instructional approach for enhancing the English language competencies of Bachelor of Science in Criminology students within the context of English for Criminology Purposes (ECP). The integration of AI into English instruction significantly improved students' English learning achievement, as evidenced by the substantially higher posttest performance and learning gains of the experimental group compared with those who received conventional teacher-led instruction. These findings confirm that AI-assisted learning provides meaningful instructional advantages through adaptive feedback, individualized learning opportunities, immediate language support, and continuous practice that collectively strengthen learners' language proficiency.

The study further establishes that AI-assisted instruction fostered very high levels of second language (L2) motivation among the participants. Students demonstrated highly positive attitudes toward learning English, recognized its personal and professional value, and exhibited greater confidence in using English for criminology-related communication. The personalized and interactive nature of AI-supported learning environments contributed to

sustained learner engagement and strengthened students' appreciation of English as an indispensable competency in their future careers in criminal justice.

Likewise, the findings reveal that AI-assisted English language instruction substantially promoted self-regulated learning. Students consistently demonstrated very high levels of planning, goal orientation, self-monitoring, strategy implementation, evaluation, and reflective learning, indicating that AI effectively supported learner autonomy and metacognitive development. By enabling learners to independently monitor their progress, receive immediate feedback, and regulate their learning strategies, AI functioned as an instructional scaffold that encouraged lifelong learning behaviors essential for both academic success and professional practice.

Overall, the literature indicates that language competence and mathematical reasoning are interconnected through language-mediated comprehension, shared cognitive processes, and participation in mathematical discourse. These theoretical perspectives support the view that stronger English language competence may contribute to students' ability to understand, analyze, and reason through mathematical concepts and problems.

Recommendations

Based on the findings and conclusions of the study, the following recommendations are proposed:

1. **Higher Education Institutions** should consider systematically integrating AI-assisted English language instruction into the English for Criminology Purposes curriculum. AI-supported learning activities should complement existing instructional practices to enhance discipline-specific communication competencies while ensuring alignment with course outcomes and institutional learning standards. Educational institutions should integrate language-focused strategies into mathematics instruction, particularly activities that develop academic vocabulary, comprehension of mathematical problems, explanation of reasoning, and mathematical discourse, to strengthen students' mathematical reasoning skills.
2. **English language teachers and ESP instructors** are encouraged to adopt AI-assisted instructional strategies that promote personalized learning, immediate formative feedback, authentic communication tasks, and learner autonomy. However, AI should function only as an instructional support tool, with teachers maintaining their central role in facilitating critical thinking, providing contextualized feedback, and ensuring meaningful learning experiences.
3. **Curriculum developers and academic administrators** should develop structured AI integration frameworks that include discipline-specific learning activities such as police report writing, investigative documentation, courtroom communication, forensic reporting, legal correspondence, and other authentic criminology communication tasks. Clear institutional policies governing the responsible and ethical use of AI in academic settings should likewise be established.

4. **Students** should be encouraged to utilize AI responsibly as a supplementary learning resource for improving grammar, vocabulary, writing, speaking, and professional communication. They should critically evaluate AI-generated outputs, verify factual information through credible sources, avoid plagiarism, and maintain academic integrity while developing independent learning habits.
5. **Faculty development programs** should include continuous professional training on AI literacy, prompt engineering, ethical AI integration, assessment design, and technology-enhanced pedagogy to ensure that instructors possess the competencies necessary to effectively facilitate AI-assisted learning environments.
6. **Academic institutions** should strengthen digital infrastructure by providing equitable access to reliable internet connectivity, institutionally approved AI applications, and appropriate technological resources that will support sustainable implementation of AI-assisted instruction across academic programs.
7. **Given that oral briefing readiness obtained the comparatively lowest mean among the professional communication dimensions**, future instructional interventions should incorporate more face-to-face simulations, oral presentations, mock investigations, courtroom exercises, role-playing activities, and collaborative communication tasks to further strengthen students' spontaneous oral communication and public speaking competencies.
8. **Future researchers** are encouraged to replicate the study using larger and more diverse samples across multiple higher education institutions to enhance the generalizability of the findings. Future investigations may also examine the long-term effects of AI-assisted English instruction, compare the effectiveness of various AI platforms, investigate additional learner outcomes such as critical thinking, creativity, digital literacy, and academic writing quality, and employ longitudinal or experimental designs to establish stronger causal evidence regarding the educational impact of AI-assisted language learning.

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