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The Effect of ChatGPT Implementation on Right- and Left-Hemisphere Dominant Iranian EFL Learners' Argumentative Writing and Metacognitive Awareness

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A B S T R A C T

The current research investigated the impact of ChatGPT implementation on argumentative writing and metacognitive awareness among Iranian EFL learners, focusing on the moderating role of hemispheric dominance. It aimed to determine if ChatGPT differentially affects right- and left-hemisphere-dominant learners. A quasi-experimental design was employed with 60 intermediate participants aged 15-24 years from two institutes in Tabriz, Iran, who were allocated to experimental and control groups. Participants' English proficiency was measured using the Oxford Placement Test and their hemispheric dominance was determined as either left or right using the Open Hemispheric Brain Dominance Scale. Weir's rubric evaluated Argumentative writing, while metacognitive awareness was assessed using the Metacognitive Awareness Writing Questionnaire. ChatGPT was employed with the experimental groups in scheduled intervention for eight weeks; whereas, conventional instruction was given to the control groups. Data analysis through ANCOVA indicated that ChatGPT implementation significantly improved argumentative writing and metacognitive awareness among left-hemispherical learners compared to right-hemispherical learners. Small changes in control groups emphasized ChatGPT's effectiveness in analytical learners in particular. Pedagogically, this paper emphasizes the importance of personalized instruction by artificial intelligence (AI) to support cognitive variety and suggests incorporating AI in EFL to support analytical competencies tailored to learners' cognitive styles.

1. Introduction

The development of Artificial Intelligence (AI) has transformed EFL education and writing as a supportive element in language learning (Li et al., 2024). Argumentative writing, one important aspect of academic literacy, draws on thinking critically, connecting ideas coherently, and developing

metacognitive awareness (Farahian, 2015; Teng, 2025). Nevertheless, many EFL learners, including Iranian students, continuously encounter difficulties in acquiring such skills. Some features of AI-based tools like ChatGPT may support writing competency (Berk & Aydin, 2024; Ghafouri et al., 2024), but little is known about their unique effect on learners with different cognitive sets (Landrum et al., 2015), for example, with right- or left-hemisphere superiority. Since the association between the dominance of the brain hemispheres and specific language learning strategies has been established (Arabmofrad et al., 2021; Dülger, 2012), it is necessary to delve into the manifestation of ChatGPT in argumentative writing and the metacognitive awareness of Iranian EFL learners with different cognitive preferences.

Hemispheric dominance is crucial in determining how learners process information cognitively and linguistically (Suwarto & Hidayah, 2023). Individuals with left-hemisphere dominance are better at analytical, sequential, and logical reasoning, resulting in their superior ability in structured and rule-governed tasks, including tasks of syntax, grammar, and construction of logical arguments (Weisi & Khaksar, 2015). On the other hand, right-hemisphere-dominant individuals tend to lean towards holistic thinking, creativity, and context while processing information, which can contribute to their style of writing, coherence, and how well they can construct more nuanced arguments (Salehi et al., 2017). Therefore, being aware of learners' different cognitive styles may help determine how they react to writing help derived from AI. Although Esmaeil et al. (2023) and Mahapatra (2024) have focused on the general advantages of ChatGPT in writing lessons, the specific needs of left- and right-brain-dominant learners concerning AI tools have yet to receive adequate attention. Moreover, since metacognitive strategies are often employed and experienced differently by learners depending on their cognitive styles (Pitenoee et al., 2017), it becomes essential to explore how hemispheric dominance might shape learners' metacognitive engagement when interacting with AI-supported writing tools.

Metacognitive awareness, which controls the cognitive apparatus, is important in academic writing (Pitenoee et al., 2017). Metacognitive strategies such as planning, monitoring, and evaluating writing employed by effective writers make coherent and well-organized products (Shen & Tao, 2025). Moreover, studies have shown that students with high metacognitive awareness tend to perform better in writing tasks since they reflect on their cognitive processes (Teng, 2025). ChatGPT feedback is instantaneous and advises on structural issues, it could enhance metacognition (Abdelhalim, 2024). Nevertheless, whether right- or left-hemisphere dominant learners gain the same benefits from such AI-supported writing assistance is questionable. While the studies suggest the opposite, AI-written feedback potentially benefits analytical learners with strengths in logical structuring (Li et al., 2024), but creative learners may face challenges with its rigid, systematic nature (Jiang & Hyland, 2024). This difference highlights the importance of exploring the impact of ChatGPT implementation on metacognitive awareness concerning differing cognitive profiles (Tabib & Alrabeei, 2024).

Previous studies primarily focus on AI-supported writing instruction in general (e.g., Guo et al., 2024; Su et al., 2023; You et al., 2024) without accounting for the diversity in writing cognition among learners. Rai (2024) and Suwarto and Hidayah (2023) reveal that brain dominance affects language acquisition, as shown in the findings that right-brain-dominant students tend to have an abstract and intuitive style, while students with left-brain dominance prefer the analytical style (Ashraf et al., 2017; Lingard, 2023). This distinction is important in how AI-generated feedback affects people with different cognitive strengths and weaknesses.

Furthermore, Iranian EFL learners have special linguistic and cultural problems that can influence their writing. According to Moghadam and Jafarpour (2021), Persian is a right-to-left language with a dissimilar syntactic structure compared to English, which makes English structurally and conceptually difficult to learn. As a result, Persian-speaking students usually face difficulties regarding coherence, cohesion, and development in writing a coherent argument in English (Esfandiari & Allaf-Akbary, 2024). Also, different cultural beliefs toward writing and creativity could affect how much learners engage with AI-assisted instruction. Although ChatGPT streamlines the writing process (Zhang et al., 2025), its effectiveness for Iranian learners with diverse cognitive styles has not been widely studied.

Given that the Iranian EFL context lacks the implementation of the importance of critical thinking and self-regulation (Mohammadi et al., 2020), understanding how the integration of ChatGPT can play a role in such metacognitive awareness becomes a nation-specific concern. While studies have indicated that AI tools can help boost student engagement and motivation regarding writing tasks (Song & Song, 2023; Zare et al., 2025), ultimately, the effectiveness of AI tools will come down to how well they cater to learners' cognitive styles. If AI feedback primarily caters to left-brain learners, right-brain learners could struggle with the rigid nature of this feedback. On the one hand, if AI tools foster holistic thought and creativity, left-brain-dominant learners may flounder with impressionistic prompts. This potential discrepancy poses a nuanced inquiry into the efficacy of ChatGPT across cognitive styles.

Another critical aspect of this research is the comparative analysis of argumentative writing improvement between right- and left-hemisphere dominant learners. While previous studies have examined general improvements in writing skills with AI assistance (Bašić et al., 2023; Khampusaen, 2025), they have not specifically addressed cognitive differences. By examining whether ChatGPT disproportionately benefits one cognitive group over the other, this study will provide insights into the adaptability of AI-assisted writing instruction. Furthermore, investigating the impact on metacognitive awareness will reveal whether learners with different cognitive tendencies develop self-regulated learning strategies at comparable rates when using ChatGPT.

One major aspect of this research is the comparative examination of argumentative writing among right- and left-hemisphere dominant learners. Previous studies have explored general writing skills using AI assistance (e.g., Bašić et al., 2023; Khampusaen, 2025) but have not addressed cognitive differences. Analyzing the extent to which an AI tool such as ChatGPT gives undue advantage to one cognitive category or the other will afford us insights into the extent to which AI-supported writing instruction is an opportunity for innovation. Moreover, exploring its influence on metacognitive awareness will help identify if ChatGPT facilitates the development of self-regulated learning in learners with divergent cognitive inclinations at similar paces.

Without consideration of these cognitive differences, AI-assisted language learning can carry serious consequences. Whereas AI-based instruction primarily caters to sound analytical skills, this could lead to frustration and disengagement for creative learners (Urban et al., 2024). Conversely, when the tool fails to provide enough structure, left-brain-oriented learners may find it lacking coherence and logical flow in their writing (Khoiriah, 2019). It will be important to mitigate these potential disparities to provide equitable access to effective AI-assisted writing instruction. Moreover, a better understanding of the interaction between cognitive styles and AI tools can guide the development of individual learning strategies that will ultimately increase writing skills and metacognitive awareness.

Previous studies have increasingly explored the role of AI tools, particularly ChatGPT, in enhancing writing instruction within EFL contexts. Research has shown that AI-assisted writing platforms provide timely, structured, and grammar-oriented feedback that benefits learners' writing fluency and accuracy (Berk & Aydin, 2024; Ghafouri et al., 2024). For example, Esmaeil et al. (2023) and Mahapatra (2024) documented positive learner perceptions and improved writing quality when ChatGPT was integrated into writing instruction. However, these studies often treated learners as a homogeneous group, overlooking individual differences in cognitive processing styles. Meanwhile, studies examining brain hemispheric dominance have established its significant influence on language learning strategies and writing styles (Arabmofrad et al., 2021; Dülger, 2012; Suwarto & Hidayah, 2023). Learners with left-brain dominance typically prefer structured, analytical tasks, while right-brain-dominant learners excel in creative and intuitive reasoning (Salehi et al., 2017; Weisi & Khaksar, 2015). Despite this, little empirical work has connected hemispheric dominance with AI-assisted writing development. Moreover, although research supports the role of metacognitive awareness in writing proficiency—highlighting that learners who actively plan, monitor, and evaluate their writing tend to perform better (Farahian, 2015; Pitenoee et al., 2017; Teng, 2025)—few studies have investigated whether AI tools like ChatGPT influence metacognitive development differently based on cognitive style. Therefore, there remains a crucial gap in understanding how ChatGPT interacts with individual cognitive traits, particularly brain dominance, to influence both writing performance and metacognitive growth.

The study endeavors to fill the gap in the literature through an in-depth exploration of the influence of using ChatGPT on argumentative writing and the metacognitive awareness of right vs. left-hemisphere-dominant Iranian EFL learners. This study will address this gap in the field by investigating the interplay between AI-assisted feedback and cognitive styles, providing insight for a more holistic understanding of technology-enhanced language learning. Thus, these findings will enhance EFL pedagogy, AI-assisted education, and instructional design, leading to more inclusive and effective writing instruction. The growing use of AI in educational settings underscores the need to ensure that such tools support diverse cognitive profiles with equitable and personalized learning experiences for EFL learners and leads to the following research questions:

RQ1. Does using ChatGPT have any statistically significant impact on Iranian EFL learners' right and left hemisphere dominance in their argumentative writing?

RQ2. Does using ChatGPT have any statistically significant impact on Iranian EFL learners' right and left hemisphere dominance in their metacognitive awareness?

2. Methodology

The study followed a quantitative research approach, adopting a quasi-experimental design, which had a pre-test-post-test-control group design, requiring the existence of four groups: two experimental groups and two control groups. Quasi-experimental research is research that includes experimentation but is not truly experimental. Instead, their effects are based on the manipulation of the independent variable (Cook & Campbell, 1979). Participants are not randomly assigned to conditions or sequences of conditions. In this study, the experimental group was given written treatment by the innovative methodologies of ChatGPT, and the control group was instructed conventionally. Thus, the dependent variables in the scope of this study were argumentative writing

and metacognitive awareness, while ChatGPT implementation served as the independent variable. Moreover, the left hemisphere vs. right hemisphere dominance functioned as moderating variables.

2.1 Participants and Setting

The participants were selected from a population of 80 from two different institutes in Tabriz, namely Pardisan and Goldis. The final homogeneous sample consisted of 60 intermediate male EFL learners, aged 15–24 years, all native Persian speakers, recruited from the institutes following identical curricula. This method guarantees that participants have been exposed to a comparable academic background. According to the placement criteria of the institutes, they were intermediate students. Nonetheless, to guarantee the integrity and uniformity of the participants, a proficiency test was administered before the commencement of the primary research. From the proficiency test, selected candidates with scores in the range of 30-39 were classified as lower intermediate. Participants were then non-randomly allocated to the experimental or control groups. These included 30 students from Pardisan Institute in the experimental groups and 30 students from Goldis Institute in the control groups. Originally, there were 34 students in the two Goldis Institute classes, but to equalize their numbers with those of the Pardisan Institute, four participants were excluded. Additionally, participants completed a hemispheric dominance scale following the proficiency test to determine left-hemisphere vs. right-hemisphere dominant learners. All groups were then split into the left-hemisphere and right-hemisphere dominant groups. After administering the aforementioned scale, four groups were formed: two experimental groups, the Experimental Left-Hemisphere Dominant (ELHD) group and the Experimental Right-Hemisphere Dominant (ERHD) group, and two control groups, the Control Left-Hemisphere Dominant (CLHD) group and the Control Right-Hemisphere Dominant (CRHD) group, each consisting of 15 learners. The same instructor taught all groups to eliminate teacher confounding variables. The participants had already studied Evolve 1-3 level. They remained in Evolve 4 level for the duration of the study.

2.2 Instrumentation

To gather the data needed for the study, the researchers employed the following instruments at various stages of the study.

Oxford Placement Test (OPT)

The OPT developed by Dave (2004) was systematically applied to assess and verify whether the proficiency levels of the English language differed in any significant ways between the experimental and control groups investigated. The test is a well-structured formal evaluation divided into six levels of proficiency on the CEFR scale and assigns test scores to well-defined value boundaries for each of the discrete levels: Basic (A1: 0–17), Elementary (A2: 18–29), lower intermediate (B1: 30–39), upper intermediate (B2: 40–47), advanced (C1: 48–54), and very advanced (C2: 54–60). These categorizations conform to established standards of language proficiency, enabling the assessment of participants' skills. The OPT results collected at the onset of the study were vital in that they provided researchers with the ability to intentionally select individuals whose scores fell into the Lower Intermediate (B1: 30–39) range to maintain uniform language proficiency standards within the groups.

Open Hemispheric Brain Dominance (OHBD) Scale

The OHBD scale was created by Jorgenson (2015) to identify left-hemisphere vs. right-hemisphere dominance, used in the current research to split participants into right-brain and left-brain dominant groups. The questionnaire comprised 20 items on a five-point Likert-type scale from disagree (1) to agree (5). The scale ranges from 20 to 100, which is the minimum and maximum possible score. Per this questionnaire, the participants whose total score was between 20-55 were thought of as left hemisphere dominant, and learners whose total score was between 65-100 were treated as right hemisphere learners. The scale was translated into Persian, and the validity of the translated version was confirmed by two experts. To measure the reliability for internal consistency, Cronbach's alpha was used and showed a high coefficient of 0.89.

Argumentative Writing Tests

During the data collection procedure, participants were required to write two argumentative essays (pre-test and post-test). The pre-test was done one session before the treatment began, and the post-test was performed after the eight-session intervention was finished. The main purpose was to assess the written ability of students taking part in the intervention. The essays were scored using Weir's (1990, as cited in Ahour & Mukundan, 2009) analytic rubric, which is a validated tool designed to measure argumentative writing performance in important areas, such as ideas and content, organization, coherence and cohesion, voice, sentence fluidity, and grammatical accuracy. The writing topic was selected from NTC's TOEFL materials and was carefully adapted for lower-intermediate learners to ensure accessibility in terms of vocabulary, structure, and task demands. Although originally designed for higher proficiency levels, TOEFL-style prompts were used to expose learners to authentic academic tasks while maintaining an achievable level of complexity. The adapted version allowed participants to demonstrate key argumentative skills, such as stating a position, providing reasons, and organizing ideas coherently, within a manageable linguistic range. The prompt was reviewed by two EFL instructors to confirm its appropriateness for the learners' level and was then shared with all participants. This prompt formed the basis of an essay task that participants were to carry out before and after the intervention, wherein they wrote an essay of about 150-250 words. Fifty minutes was the time allotted for each session. Inter-rater reliability was used to maintain the validity of the assessment process. To do this, the essays were rated by two independent raters to confirm the consistency of the scoring. High agreement between raters indicated reliable scoring. In cases of substantial disagreement, discussions were conducted between the raters to resolve differences and achieve consensus. Weir's analytic scale includes several assessment factors: the relevance and adequacy of content, the organization of composition, cohesion, spelling, punctuation, adequacy of vocabulary for the intended purpose, and grammatical accuracy. The first three criteria are related to fluency, and the other criteria touch on writing accuracy.

Metacognitive Awareness Writing Questionnaire (MAWQ)

The MAWQ, originally developed by Schraw and Dennison (1994) as a general metacognitive awareness inventory and later adapted and validated for EFL writing by Farahian (2015), was used in this study to assess participants' metacognitive awareness in writing. The MAWQ, which is a 55-item questionnaire, evaluates two key components: Knowledge of Cognition, which includes declarative, procedural, and conditional knowledge, and Regulation of Cognition, which encompasses planning, audience consideration, monitoring, online strategies, revision, and evaluation. To examine changes in learners' metacognitive awareness, the questionnaire was administered in printed form both before

and after the treatment. To ensure accessibility for participants, the questionnaire was translated into Persian, and the translated version was verified by two experts for accuracy and clarity. The overall possible score on the measure ranged from 55 to 275. The original study by Farahian (2015) reported Cronbach's alpha reliability values ranging from 0.67 to 0.91 across different subscales, confirming its reliability as a metacognitive assessment tool. In this study, the overall Cronbach's alpha coefficient was calculated at 0.82, further demonstrating the internal consistency of the instrument.

2.3 Research Procedure

This study utilized a pre-test and post-test quasi-experimental design to explore the impact of ChatGPT on the argumentative writing and metacognitive awareness of the Iranian EFL learners with right- and left-hemisphere dominance. The procedure was grounded in rigorous, reliable, ethical principles, systematic steps were implemented chronologically from November 2024 to January 2025 at Pardisan and Goldis Language Institutes, Tabriz, Iran. The study was approved by the Ethical Committee of Pardisan and Goldis Language Institutes, and they acted as the gatekeepers to ensure that ethical research matters were addressed before the study. Recruitment was conducted during regular class sessions. The researcher described the purpose, procedures, and voluntary nature of the study and assured participants of anonymity and confidentiality as well as the right to withdraw from the study without consequence. Informed written consent was obtained from all subjects using printed forms that were signed, returned, and kept in a locked filing cabinet accessible to the researcher.

To establish baseline equivalence, two assessments were given. To ensure homogeneity amongst participants, the OPT was first conducted in a 60-minute session where all participants took part. Answer sheets were collected manually and scored by the researchers using the official scoring key. Only participants with a scores within the range of 30–39 (lower-intermediate, B1) were considered to maintain consistency. Out of an original pool of 80 male students, only 60 were kept, with 20 ruled out because their scores were outside of this range. Results were entered manually in a spreadsheet, with a colleague double-checking the scores for accuracy. Additionally, the OHBD scale was used to help classify participants as left- or right-hemisphere dominant. It was handed out on paper as part of a 30-minute session. The participants completed it individually, their responses were manually collected, scored, and categorized: 20–55 (left-hemisphere dominant) and 65–100 (right-hemisphere dominant). They were then non-randomly assigned to one of four groups of 15: ELHD, ERHD, CLHD, and CRHD. Experimental groups (n=30) from Pardisan Institute and control groups (n=30) from Goldis Institute ensured inter-institutional uniformity. To control for teacher-related variation, all groups were taught by the same instructor, fluent in Persian and English.

Prior to the treatment, baseline data on argumentative writing and metacognitive awareness were collected. First, the argumentative writing pre-test was administered in a 50-minute session. Participants wrote a 150–250-word essay on the prompt: "Do you agree or disagree with the statement: ChatGPT access must be limited to students?" This topic was deliberately selected for its immediate relevance to the participants, as all were EFL students who had encountered or were aware of AI in their educational experience. The topic was relatable and thought-provoking, encouraging critical engagement and allowing students to draw on their perspectives and experiences with AI tools in academic contexts. Essays were handwritten on standardized answer sheets, collected manually, and scored by two independent raters using Weir's (1990, as cited in Ahour & Mukundan, 2009) analytic rubric, focusing on content, organization, cohesion, vocabulary, and grammar. Scores were recorded manually on a scoring sheet, and inter-rater reliability was calculated, with discrepancies

resolved through discussion to ensure consistency. Then, MAWQ was administered in a 40-minute session. It was distributed in print and recorded in the spreadsheet. The consistent application of these validated instruments, used in similar contexts (e.g., Farahian, 2015; Ahour & Mukundan, 2009), ensured reliability and validity, as supported by a high inter-rater reliability coefficient for the writing pre-test scores ($r = .945$, $p < .001$).

Over eight weeks, once a week for 50 minutes, the experimental groups were instructed using ChatGPT, whereas the control groups were instructed by conventional instruction. Each session opened with a 15-minute mini-lecture on the elements of argumentative writing (e.g., essay formulation, counterarguments). Over the next few weeks, participants worked with ChatGPT via their smartphones, engaging in scaffolded writing activities built around structured prompts. These included tasks such as "List three arguments for and against limiting student ChatGPT access" (for idea generation), "Improve this paragraph's coherence by using appropriate transitions" (for organization and cohesion), and "Revise this statement to make it clearer and more specific" (for clarity and argumentative strength). Participants were also asked to copy-paste their own writing into ChatGPT and request suggestions for improvement, such as grammar corrections or alternative vocabulary. They, then revised their drafts based on the AI-generated feedback and were encouraged to reflect on the changes they made and the reasons why they made changes. This iterative process was monitored by the instructor, who ensured that all learners actively used ChatGPT and received equitable support during sessions. Participants kept hand-written reflective journals (one entry per session of ~100 words) to prompts such as "In what way did the feedback offered by ChatGPT strengthen your argument?" Journals were collected and locked away every week.

Control groups used teacher-centered methodologies, mirroring experimental structure without AI tools. They would then draft, get instructor feedback related to grammar and organization, and go through peer reviews after a 15-minute lecture." Metacognitive reflection was prompted through oral Socratic questioning (e.g., "Why is this evidence persuasive?"). Weekly handwritten drafts were collected for consistent feedback.

Under identical conditions to the pre-tests, after conducting treatment, post-intervention data were collected. All data were stored and anonymized using participant codes (e.g., ELHD-01). Writing tests were scored on separate sheets, with rater scores averaged after consensus. The same classroom conditions (e.g., lighting, seating) and timing (morning sessions) were maintained across institutes to minimize external variables. Data analysis was conducted in SPSS 27, with pre- and post-test scores compared using one-way Analysis of Covariance (ANCOVA), ensuring statistical rigor.

3. Data Analysis

In order to answer the posed research questions, some calculations, statistical routines, and results were produced, which will be explained in detail in this section. The details about descriptive statistics of groups regarding the study variables (argumentative writing and metacognitive awareness) are illustrated in Table 1.

Table 1

Group Statistics

Tests	Groups	N	Mean	SD	SE Mean
Argumentative Writing Pre-Test	ELHD Group	15	19.66	1.447	.373
	ERHD Group	15	19.80	1.740	.449
Argumentative Writing Post-Test	ELHD Group	15	31.86	1.597	.412
	ERHD Group	15	30.06	1.830	.472
MAWQ Pre-Test	ELHD Group	15	125.86	2.587	.668
	ERHD Group	15	125.93	3.348	.864
MAWQ Post-Test	ELHD Group	15	231.53	3.270	.844
	ERHD Group	15	225.93	3.348	.864

As Table 1 demonstrates, the mean score of the argumentative writing pre-test for the ELHD group is 19.66 (SD = 1.447, SE = .373), and the ERHD group had a mean of 19.80 (SD = 1.740, SE = .449). Following the intervention, both groups showed significant improvement in argumentative writing, with the ELHD group having a mean score of 31.86 (SD = 1.597, SE = .412) and the ERHD group up to 30.06 (SD = 1.830, SE = .472). Concerning the metacognitive awareness, which was measured through the MAWQ, the means for the pre-test were equivalent, with the ELHD at 125.86 (SD= 2.587, SE= .668) and the ERHD group at 125.93 (SD = 3.348, SE = .864). Post-test scores showed significant increases after the test, with 231.53 (SD = 3.270, SE = .843) and the ERHD group scoring 225.93 (SD = 3.348, SE = .864), signifying significant improvements in metacognitive awareness for both groups, where the ELHD group scored slightly higher than the ERHD group in both post-tests. Additionally, the Pearson correlation coefficient was used to evaluate inter-rater reliability and compare the consistency between both raters. These analyses are outlined in Table 2.

As Table 2 displays, for the pretest scores, the inter-rater correlation was almost perfect for the control group, as $r = .945$ ($p < .001$), i.e., excellent scoring consistency. In the same way, the pretest scores of the experimental group exhibited identical reliability ($r = .945$, $p < .001$), indicating that raters consistently applied the scoring criteria between groups at baseline prior to intervention. Post-test scores showed even greater agreement, with correlations climbing to $r = .993$ ($p < .001$) for the control and experimental groups, respectively. Considering this high level of inter-rater agreement, one can conclude that both raters provided an equal level of accuracy and objectivity in assessing participants' performance in the pretest. Moreover, Levene's Test of Equality of Error Variances was administered to find out whether the error variance of the dependent variables was equal across the groups. Table 3 demonstrates these results.

Table 2

Inter-Rater Correlation for the Argumentative Writing Test Scores

		Rater 1	Rater 2
Pretest of Control Groups (Rater 1)	Pearson Correlation	1	.945**
	Sig.(2-tailed)		.000
	N	30	30
Pretest of Experimental Groups (Rater 2)	Pearson Correlation	.945**	1
	Sig.(2-tailed)	.000	
	N	30	30
Posttest of Control Groups (Rater 1)	Pearson/Correlation	1	.993**
	Sig.(2-tailed)		.000
	N	30	30
Posttest of Experimental Groups (Rater 2)	Pearson/Correlation	.993**	1
	Sig.(2-tailed)	.000	
	N	30	30

**. Correlation/is/significant at the 0.01 level (2-tailed).

According to Table 3, the results showed that for the argumentative writing post-test, the test statistic was F(3, 56) = 0.326, with a significance value of .807, indicating that the null hypothesis of equal error variance across all the groups cannot be rejected, thus confirming homogeneity of variance. For the MAWQ post-test, the test statistic was F (3, 56) = 2.704, with a significance value of .054, which is marginally above the .05 threshold, suggesting that the assumption of equal error variance across groups is also reasonably met. These findings support the use of ANCOVA for analyzing both dependent variables, as the assumption of homogeneity of variance is generally upheld.

Table 3

Levene's Test of Equality of Error Variances for Argumentative Writing and MAWQ Post-test Scores

Scores

Tests	F	df1	df2	Sig.
Argumentative Writing Posttest	0326	3	56	.807
MAWQ Post-Test	2.704	3	56	.054

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Results for the First Research Question

An ANCOVA was performed to determine whether ChatGPT implementation has any statistically significant impact on argumentative writing in terms of Iranian EFL learners' right- and left-hemisphere dominance. In this analysis, the post-test scores for argumentative writing served as the dependent variable, while the pre-test scores were used as a covariate to control for initial writing abilities. The independent variable, representing different group conditions (such as AI-assisted writing versus traditional methods), was used to capture variations in hemisphere dominance.

Table 4

ANCOVA Results: Effects of ChatGPT Usage on Argumentative Writing Test Scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1044.045[a]	4	261.011	100.997	.000	.880
Intercept	276.635	1	276.635	107.043	.000	.661
Writing pre-test	.128	1	.128	.049	.825	.001
group	1040.856	3	346.952	134.252	.000	.880
Error	142.139	55	2.584			
Total	44549.000	60				
Corrected Total	1186.183	59				

a. R Squared = .880 (Adjusted R Squared = .871)

The results, presented in Table 4, indicate that the overall corrected model, including the intercept, pre-test, and group, was statistically significant ($F(4, 55) = 100.997$, $p < .001$), explaining 88.0% of the variance in argumentative writing post-test scores (R Squared = .880, Adjusted R Squared = .871). The intercept was also statistically significant ($F(1, 55) = 107.043$, $p < .001$), with a partial eta squared of .661, indicating that the overall mean of the post-test scores, adjusted for the covariate, is significant. The argumentative writing pre-test scores, serving as a covariate, showed a marginally significant effect on post-test scores ($F(1, 55) = 0.49$, $p = .825$), with a partial eta squared of .001, suggesting that baseline writing scores have little influence on post-test outcomes. Most importantly, the group variable, representing the extent of ChatGPT usage, had a highly significant effect on argumentative writing post-test scores ($F(3, 55) = 134.252$, $p < .001$), with a partial eta squared of .880, indicating that 88.0% of the variance in post-test scores is explained by the extent of ChatGPT usage, demonstrating a strong and statistically significant impact on argumentative writing performance among groups. To further explore the differences among groups, pairwise comparisons were conducted using Bonferroni-adjusted significance levels.

Table 5

Pairwise Comparisons of ChatGPT Usage Effects on Argumentative Writing Test Scores

					95% Confidence Interval for Difference[b]	
(I) group	**(J) group**	**MD (I-J)**	**SE**	**Sig.[b]**	**Lower Bound**	**Upper Bound**
ELHD Group	ERHD Group	1.796*	.587	.021	.189	3.403
	CLHD Group	8.261*	.588	.000	6.652	9.869
	CRHD Group	9.879*	.589	.000	8.265	11.492
ERHD Group	ELHD Group	-1.796*	.587	.021	-3.403	-.189
	CLHD Group	6.465*	.587	.000	4.858	8.072
	CRHD Group	8.083*	.591	.000	6.464	9.701
CLHD Group	ELHD Group	-8.261*	.588	.000	-9.869	-6.652
	ERHD Group	-6.465*	.587	.000	-8.072	-4.858
	CRHD Group	1.618	.593	.051	-.004	3.240
CRHD Group	ELHD Group	-9.879*	.589	.000	-11.492	-8.265
	ERHD Group	-8.083*	.591	.000	-9.701	-6.464
	CLHD Group	-1.618	.593	.051	-3.240	.004

Based on estimated marginal means
*. The mean difference is significant at the .05 level.
b. Adjustment for multiple comparisons: Bonferroni.

As Table 5 represents, the results indicate the following key findings: The ELHD group performed significantly better than the ERHD group (MD= 1.796, p = .021), CLHD group (MD= 8.261, p < .001), and CRHD group (MD= 9.879, p < .001). The ERHD group showed significant differences compared to the CLHD group (MD= 6.465, p < .001) and CRHD group (MD= 8.083, p < .001), with lower performance levels. The CLHD group had significantly lower scores than the ELHD group (MD= -8.261, p < .001) and the ERHD group (MD= -6.465, p < .001). However, the difference between CLHD and CRHD groups was not significant (p = .051). The CRHD group had the lowest performance, significantly differing from the ELHD (MD= -9.879, p < .001) and ERHD groups (MD= -8.083, p < .001), but not significantly different from the CLHD group (p = .051). These results suggest that ELHD learners had the highest post-test argumentative writing scores; whereas, CRHD learners had the lowest. The differences between groups were statistically significant in most cases, indicating that hemisphere dominance plays a critical role in writing performance.

Results for the Second Research Question

This study also investigated whether using ChatGPT has a statistically significant impact on the right and left hemisphere dominance in the metacognitive awareness of Iranian EFL learners. The results are summarized in Table 6.

Table 6

ANCOVA Results: Effects of ChatGPT Usage on MAWQ Scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	17136.687[a]	4	4284.172	2076.101	.000	.993
Intercept	254.637	1	254.637	123.397	.000	.692
MAWQ pretest	330.637	1	330.637	160.226	.000	.744
group	16488.012	3	5496.004	2663.352	.000	.993
Error	113.496	55	2.064			
Total	2716859.000	60				
Corrected Total	17250.183	59				

a. R Squared = .993 (Adjusted R Squared = .993)

The results from Table 6 indicate that the overall corrected model, including the intercept, pretest, and group, was statistically significant ($F(4, 55) = 2076.101$, $p < .001$), explaining 99.3% of the variance in MAWQ post-test scores (R Squared = .993, Adjusted R Squared = .993). The pretest scores significantly predicted post-test scores ($F(1, 55) = 160.226$, $p < .001$), with a partial eta squared of .744, indicating that 74.4% of the variance is explained by baseline metacognitive awareness. Most notably, the group variable, representing the extent of ChatGPT usage, had a highly significant effect on MAWQ post-test scores ($F(3, 55) = 2663.352$, $p < .001$), with a partial eta squared of .993, suggesting that 99.3% of the variance is explained by ChatGPT usage, demonstrating an extremely strong and statistically significant impact on hemispheric dominance in metacognitive awareness. To further clarify the differences between groups, pairwise comparisons were conducted and are presented in Table 7.

Table 7

Pairwise Comparisons of ChatGPT Usage Effects on MAWQ Scores

					95% Confidence Interval for Difference[b]	
(I) group	**(J) group**	**MD (I-J)**	**SE**	**Sig.[b]**	**Lower Bound**	**Upper Bound**
ELHD Group	ERHD Group	5.660*	.525	.000	4.224	7.096
	CLHD Group	35.667*	.525	.000	34.231	37.102
	CRHD Group	35.921*	.526	.000	34.481	37.360
ERHD Group	ELHD Group	-5.660*	.525	.000	-7.096	-4.224
	CLHD Group	30.007*	.525	.000	28.571	31.443
	CRHD Group	30.261*	.526	.000	28.821	31.701
CLHD Group	ELHD Group	-35.667*	.525	.000	-37.102	-34.231
	ERHD Group	-30.007*	.525	.000	-31.443	-28.571
	CRHD Group	.254	.526	1.000	-1.185	1.694
CRHD Group	ELHD Group	-35.921*	.526	.000	-37.360	-34.481
	ERHD Group	-30.261*	.526	.000	-31.701	-28.821
	CLHD Group	-.254	.526	1.000	-1.694	1.185

Based on estimated marginal means
*. The mean difference is significant at the .05 level.
b. Adjustment for multiple comparisons: Bonferroni.

As Table 7 illustrates, the results, adjusted for multiple comparisons using the Bonferroni correction, revealed significant mean differences between all pairs of groups ($p < .001$), except for the comparison between the CLHD group and the CRHD group ($p = 1.000$), which showed no significant difference (MD= -.254). Specifically, the ELHD group, which received experimental AI-based intervention and exhibited left-hemisphere dominance, scored significantly higher on the MAWQ post-test than the ERHD group, which received the same intervention but exhibited right-hemisphere dominance (MD= 5.660, $p < .001$). The ELHD group also scored significantly higher than the CLHD group (MD= 35.667, $p < .001$) and the CRHD group (MD= 35.921, $p < .001$), both of which served as control groups with no ChatGPT intervention. The ERHD group scored significantly higher than the CLHD group (MD= 30.007, $p < .001$) and the CRHD group (MD= 30.261, $p < .001$). Additionally, the CLHD group scored significantly higher than the CRHD group (MD= 2.54, $p < .001$). These findings indicate that the use of ChatGPT, particularly in the experimental groups (ELHD & ERHD), significantly enhances metacognitive awareness and differentiates levels of right and left hemisphere dominance compared to the control groups (CLHD & CRHD), with the ELHD group consistently showing the highest scores and the CRHD group the lowest, except for the non-significant difference between the CLHD and CRHD groups.

4. Discussion and Conclusion

The results of this research provide strong evidence for the differential effects of ChatGPT on argumentative writing and metacognitive awareness of Iranian EFL learners having different hemispheric dominance profiles, answering the two fundamental research questions put forth. For the first research question, which sought to find out whether ChatGPT has a statistically significant impact on argumentative writing conditioned on left- or right-hemisphere dominance, the results are robust. ANCOVA analysis showed that ChatGPT use explained 88% of the variance in post-test argumentative writing scores, which was significant, such that the ELHD group outperformed all other groups, including the ERHD group. Such a structured approach might be more beneficial for leaners with left brain dominance who are more logical and analytical in their processing style (Weisi & Khaksar, 2015); they add correctness to their sequential levels of predictions and additions, and it is not uncommon for these students to have strict accuracy aspects and logical coherence in their output. By contrast, right-hemisphere dominant learners, who tend to thrive through holistic and creative thinking (Salehi et al., 2017), improved only modestly, falling behind their left-hemisphere peers, perhaps due to a misalignment between their cognitive styles and the AI's pattern-oriented advice (Jiang & Hyland, 2024). This finding, in line with Arabmofrad et al. (2021) and Dülger's (2012) studies, suggests that cognitive styles have an impact on language learning outcomes and expands upon this knowledge in the context of AI-supported writing.

In contrast, as demonstrated by the control groups, CLHD and CRHD scored significantly lower on their post-test as compared to their experimental counterparts, further emphasizing ChatGPT's effectiveness in enhancing writing skills, in concordance with findings from Bašić et al. (2023) and Khampusaen (2025). An unexpected finding, however, was a non-significant difference between the CLHD and CRHD groups ($p = .051$) despite the established cognitive differences between such profiles. The results might be due to conventional teaching's one-size-fits-all method, which may have failed to capitalize on the distinct advantages of each group, resulting in their performance even out. On the other hand, the small sample size may have had insufficient statistical power to detect subtle differences, which should be investigated further. The better performance of the ELHD group than the ERHD group also echoes with those of Li et al. (2024), who also discovered a higher efficacy of AI-based feedback for analytical learners, but the current research extended the findings by identifying hemispheric dominance as a key dimension in their analysis where it has not previously been considered.

Concerning the second research question, which examined ChatGPT's effect on metacognitive awareness based on hemispheric dominance, the results were more pronounced. The ANCOVA indicated that ChatGPT's right use accounted for 99.3% of the variance of MAWQ post-test scores, where the ELHD group performed better than both the ERHD group and both control groups again. This large effect size indicates a huge role ChatGPT plays in development, not just of writing production but also of improvement in learners' proficiency in planning, monitoring, and evaluating their processes of writing, confirming Abdelhalim (2024) and Teng (2025), who argued for AI's capacity to promote metacognitive development. The ELHD group's higher scores may be a function of their organization aligned with ChatGPT's structured prompts, which facilitate explicit reflection and revision and highly logical tasks (Ashraf et al., 2017). In contrast, the ERHD group's marginally lower gains might suggest a preference for intuitive strategies less emphasized by feedback provided by ChatGPT (Suwarto & Hidayah, 2023), but their improvement over the control groups illustrates the broader usability of the tool.

One unexpected observation was that there was no significant difference between the CLHD and CRHD groups ($p = 1.000$) when the experimental groups diverged significantly. From this perspective, metacognitive growth is potentially stimulated in these two cognitive styles when teachers deliver and provide feedback on their work and when peers review their output alike, confirming and diverging from Pitenoee et al. (2017), who argued that there is a need for explicit training on metacognitive skills. While Berk and Aydin (2024) confirmed the facilitative role of AI-powered tools in self-regulation, the extraordinary gains in MAWQ scores (e.g., ELHD: 125.86 to 231.53) among experimental groups further substantiates the strategy concerning hemispheric dominance that is uniquely attributed in the study to help the users better off. This difference in motivation and action between ChatGPT and a control group resonates with the findings of Song and Song (2023) that students receiving AI assistance in that study showed more motivation, thus likely aiding the metacognitive gains expected to be accrued in our ChatGPT condition.

The importance of these results comes from the insight they provide into how cognitive profiles mediate the effectiveness of AI-assisted learning, a dimension that has been underexplored in previous research (Guo et al., 2024; Su et al., 2023). Learners with left-hemisphere dominance seem to benefit from ChatGPT's analytical scaffolding, generating more coherent, logically structured arguments (Zhang et al., 2025). This implies that right-hemisphere dominant learners, though still benefiting from technical thinking, may have to put in extra work to utilize their creative strengths within AI frameworks, a challenge blurted in Urban et al. (2024). This differential impact highlights the brittle simplicity of the one-size-fits-all assumptions of many AI studies (e.g., Mahapatra, 2024) while reinforcing the necessity of contextually appropriate instructional design.

The implications of this study on theory, practice, and pedagogy are multifaceted. By introducing AI as an influencing factor (Rai, 2024; Suwarto & Hidayah, 2023) at a theoretical level, the present research extends the literature related to brain dominance and language acquisition, revealing that cognitive styles not only define conventional learning strategies but also have an evolving relationship with technological mediation. The findings theoretically call for incorporating ChatGPT into EFL writing instruction, particularly in traditional contexts such as Iran, in which rote learning is often favored by writing teachers to promote their students' success on tests rather than nurturing their critical thinking (Esfandiari & Allaf-Akbary, 2024). This approach serves to facilitate both writing skills and metacognitive awareness, which accommodates the longstanding difficulties in coherence and argumentation exhibited by Persian-speaking learners, as noted in Zare et al. (2025). For policy, these findings highlight the importance of educational stakeholders keeping cognitive diversity in mind while adopting the technology to ensure equitable benefits based on learners' profiles. In this way, this study extends Tabib and Alrabeei's (2024) research, who used AI to improve cognitive skills, by illustrating the hemispheric elements driving their effects.

In conclusion, this study demonstrates that ChatGPT significantly enhances argumentative writing and metacognitive awareness among Iranian EFL learners, with left-hemisphere dominant learners reaping the greatest benefits due to their alignment with the tool's structured feedback. Right-hemisphere dominant learners, while improved, show slightly lesser gains, highlighting the need for adaptive strategies to support diverse cognitive styles. These findings bridge a critical gap in AI-assisted language learning, offering actionable insights for educators and policymakers to optimize technology use in EFL contexts. By revealing the interplay between hemispheric dominance and AI efficacy, this research underscores the importance of personalized approaches, ensuring that tools like ChatGPT foster inclusive and effective learning experiences. Its impact resonates beyond Iran,

contributing to a global discourse on leveraging AI to enhance linguistic and cognitive development in education.

Overall, the results of this research show that ChatGPT has an impressive role in improving argumentative writing and metacognitive awareness of Iranian EFL students, especially those with left hemisphere dominance, who benefited the most as their characteristics fit well with the up-to-date structured feedback the tool provides. This capability is largely driven by advances in Natural Language Processing, which allow ChatGPT to analyze user input, understand linguistic structures, and generate coherent, context-sensitive feedback that aligns with academic writing conventions. While findings are evident for right-hemisphere dominant learners, they are somewhat hindered and bear evidence of requiring adaptation of principles to foster success in diverse cognitive learners. These findings help bridge a crucial gap in the literature on AI-assisted language learning, providing actionable insights for educators and policymakers to harness the use of technology in the EFL context. This research sheds light on the relationship between such hemisphere dominance and AI efficacy and shows the importance of personalized approaches, ensuring tools like ChatGPT promote learning experiences that are both user-friendly and successful. The implications are twofold, one that extends beyond Iran, as it feeds into an international conversation about using AI in education to further language and cognitive development.

While the study makes a valuable contribution, some limitations do exist. The lack of randomization in the group allocation to either of the two interventions comes with a potential selection bias, where participants from different institutes may differ on characteristics that were not measured, such as motivation or prior exposure to this type of technology. Although 60 learners were enough for a statistical analysis, it limits the generalizability, especially for intermediate Iranian EFL learners. Moreover, the study only focused on male learners, overlooking the fact that potential differences due to gender in the approaches to learning styles, technology use, or performance in writing could impact the findings. The use of self-reported hemispheric dominance through the OHBD scale (Jorgenson, 2015) further complicates matters, as behavior may not always reflect neurologic truths (Khoiriah, 2019). Furthermore, the eight-week intervention does not assess long-term effects, which was a noted limitation in similar short-term studies (You, et al., 2024). Third, the study's emphasis on argumentative writing does not represent the entire spectrum of writing genres, and ChatGPT may contribute to narrative or descriptive tasks, domains where the strengths of the right hemisphere may excel (Shen & Tao, 2025). This study was delimited to lower-intermediate male Iranian EFL learners aged 15–24, to maintain a homogenous sample in terms of language proficiency, gender, and educational context to minimize confounding variables and enhance internal validity.

These limitations open up opportunities for future research. Broader, randomized controlled studies in varied populations with EFL may help to validate these findings and improve generalizability. Employing neuroimaging or more robust cognitive assessments could sharpen the categorization of hemispheric dominance, which could mitigate any limitations from self-reporting (Arabmofrad et al., 2021). Longitudinal studies that investigate the long-term potential for ChatGPT to alter writing and metacognition would build upon Lingard (2023), who reported on the expanding role of AI in education. Exploring other genres of writing or employing adaptive, AI-enabled features for right-hemisphere learners (e.g., creativity prompts) may further level its advantages, as suggested by Jiang and Hyland (2024). Investigating cultural factors, like specifics of Persian grammatical structures or differences in attitudes toward AI, may also illuminate whether these outcomes are culturally specific (Esfandiari & Allaf-Akbary, 2024).

References

Abdelhalim, S. M. (2024). Using ChatGPT to promote research competency: English as a foreign language undergraduates' perceptions and practices across varied metacognitive awareness levels. *Journal of Computer Assisted Learning*, *40*(3), 1261–1275. https://doi.org/10.1111/jcal.12948

Ahour, T., & Mukundan, J. (2009). Analytic assessment of writing: Diagnosing areas of strength and weakness in the writing of TESL undergraduate students. *Iranian Journal of Language Studies*, *3*(2), 195–208.

Arabmofrad, A., Badi, M., & Rajaee Pitehnoee, M. (2021). The relationship among elementary English as a foreign language learners' hemispheric dominance, metacognitive reading strategies preferences, and reading comprehension. *Reading & Writing Quarterly*, *37*(5), 413–424. https://doi.org/10.1080/10573569.2020.1846005

Ashraf, H., Branch, T., & Yazdi, M. T. (2017). Brain dominance quadrants and reflective teaching among ELT teachers: A relationship study. *International Journal of English Linguistics*, *7*(2), 63–72. http://dx.doi.org/10.5539/ijel.v7n2p63

Bašić, Ž., Banovac, A., Kružić, I., & Jerković, I. (2023). ChatGPT-3.5 as writing assistance in students' essays. *Humanities and Social Sciences Communications*, *10*(1), 1–5. https://doi.org/10.1057/s41599-023-02269-7

Berk, E. H., & Aydin, S. (2024). The impact of artificial intelligence-powered writing assistance systems on metacognitive writing strategies. Retrieved from https://doi.org/10.21203/rs.3.rs-5383311/v2

Cook, T. D., & Campbell, D. T. (1979). *Quasi-experimentation: Design & analysis issues for field settings*. Houghton Mifflin.

Dave, A. (2004). *Oxford placement test 2: Test pack*. Oxford University Press.

Dülger, O. (2012). Brain dominance and language learning strategy usage of Turkish EFL learners. *Cognitive Philology*, *5*(2), 1–13. Retrieved from https://rosa.uniroma1.it/rosa03/cognitive_philology/article/view/10131

Esfandiari, R., & Allaf-Akbary, O. (2024). The role of ChatGPT-based instruction and flipped language learning in metadiscourse use in EFL learners' argumentative writing and their perceptions of the two instructional methods. *Teaching English as a Second Language Quarterly (Formerly Journal of Teaching Language Skills)*, *43*(3), 27–52. https://doi.org/10.22099/tesl.2024.49975.3277

Esmaeil, A. A. A., Dzulkifli, D. N. A. K., Maakip, I., Matanluk, O. O., & Marshall, S. (2023). Understanding student perception regarding the use of ChatGPT in their argumentative writing: A qualitative inquiry. *Jurnal Komunikasi: Malaysian Journal of Communication*, *39*(4), 150–165. https://doi.org/10.17576/JKMJC-2023-3904-08

Farahian, M. (2015). Assessing EFL learners' writing metacognitive awareness. *Journal of Language and Linguistic Studies, 11*(2), 39–51.

Ghafouri, M., Hassaskhah, J., & Mahdavi-Zafarghandi, A. (2024). From virtual assistant to writing mentor: Exploring the impact of a ChatGPT-based writing instruction protocol on EFL teachers' self-efficacy and learners' writing skill. *Language Teaching Research*, *13*(6), 216–241. https://doi.org/10.1177/13621688241239764

Guo, K., Li, Y., Li, Y., & Chu, S. K. W. (2024). Understanding EFL students' chatbot-assisted argumentative writing: An activity theory perspective. *Education and Information Technologies*, *29*(1), 1–20. https://doi.org/10.1007/s10639-023-12230-5

Jiang, F., & Hyland, K. (2024). Does ChatGPT argue like students? Bundles in argumentative essays. *Applied Linguistics*, *4*(3), 37–52. https://doi.org/10.1093/applin/amae052

Jorgenson, E. (2015). Development of the open hemispheric brain dominance scale 1.0. Available from: https://openpsychometrics.org/tests/OHBDS/development/OHBDS1.0 .pdf

Khampusaen, D. (2025). The impact of ChatGPT on academic writing skills and knowledge: An investigation of its use in argumentative essays. *LEARN Journal: Language Education and Acquisition Research Network*, *18*(1), 963–988. https://doi.org/10.70730/PGCQ9242

Khoiriah, N. (2019). *Relationship between left brain dominance and students' writing ability at Grade XI SMA Negeri 2 Padangsidimpuan* [Unpublished doctoral dissertation, IAIN Padangsidimpuan].

Landrum, A. R., Eaves, B. S., & Shafto, P. (2015). Learning to trust and trusting to learn: A theoretical framework. *Trends in Cognitive Sciences*, *19*(3), 109–111. https://doi.org/10.1016/j.tics.2014.12.007

Li, H., Wang, Y., Luo, S., & Huang, C. (2024). The influence of GenAI on the effectiveness of argumentative writing in higher education: Evidence from a quasi-experimental study in China. *Journal of Asian Public Policy,17*(2), 1–26. https://doi.org/10.1080/17516234.2024.2363128

Lingard, L. (2023). Writing with ChatGPT: An illustration of its capacity, limitations & implications for academic writers. *Perspectives on Medical Education*, *12*(1), 261–270. https://doi.org/10.5334/pme.1072

Mahapatra, S. (2024). Impact of ChatGPT on ESL students' academic writing skills: A mixed methods intervention study. *Smart Learning Environments*, *11*(1), 1–9. https://doi.org/10.1186/s40561-024-00295-9

Moghadam, M., & Jafarpour, N. (2021). A survey of part of speech tagging of Latin and non-Latin script languages: A more vivid view on Persian. *Language Arts*, *6*(1), 75–90. https://doi.org/10.22046/LA.2021.05

Mohammadi, R. R., Saeidi, M., & Ahangari, S. (2020). Self-regulated learning instruction and the relationships among self-regulation, reading comprehension, and reading problem solving: PLS-SEM approach. *Cogent Education*, *7*(1), 1–22. https://doi.org/10.1080/2331186X.2020.1746105

Pitenoee, M. R., Modaberi, A., & Ardestani, E. M. (2017). The effect of cognitive and metacognitive writing strategies on the content of the Iranian intermediate EFL learners' writing. *Journal of Language Teaching and Research*, *8*(3), 594–600. http://dx.doi.org/10.17507/jltr.0803.19

Rai, K. (2024). *Brain hemispheric dominance, metacognitive awareness, and perceptual learning style preferences as correlates of Senior secondary school students' academic achievement in biology* [Doctoral dissertation, Tezpur University].

Salehi, S., Kazemi, F., & Aslikhosh, A. (2017). Brain dominance and gender differences in writing performance of Iranian EFL learners. *Journal of Applied Linguistics and Language Research*, *4*(3), 94–104.

Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology, 19*, 460–475. https://doi.org/10.1006/ceps.1994.1033

Shen, X., & Tao, Y. (2025). Metacognitive strategies, AI-based writing self-efficacy and writing anxiety in AI-assisted writing contexts: A structural equation modeling analysis. *International Journal of TESOL Studies*, *7*(1), 70–78. https://doi.org/10.58304/ijts.20250105

Song, C., & Song, Y. (2023). Enhancing academic writing skills and motivation: Assessing the efficacy of ChatGPT in AI-assisted language learning for EFL students. *Frontiers in Psychology*, *14*(2), 126–143. https://doi.org/10.3389/fpsyg.2023.1260843

Su, Y., Lin, Y., & Lai, C. (2023). Collaborating with ChatGPT in argumentative writing classrooms. *Assessing Writing*, *57*(3), 17–32. https://doi.org/10.1016/j.asw.2023.100752

Suwarto, S., & Hidayah, A. (2023). The analysis of the brain dominance and language learning strategy used by university EFL learners. *Journal of General Education and Humanities*, *2*(1), 79–90. https://doi.org/10.58421/gehu.v2i1.64

Tabib, F. M., & Alrabeei, M. M. (2024). Can guided ChatGPT use enhance students' cognitive and metacognitive skills? In A. Al-Marzouqi & S. A. Salloum (Eds.), *Artificial intelligence in education: The power and dangers of ChatGPT in the classroom* (pp. 143–154). Springer Nature Switzerland.

Teng, M. F. (2025). Metacognitive awareness and EFL learners' perceptions and experiences in utilising ChatGPT for writing feedback. *European Journal of Education*, *60*(1), 128–141. https://doi.org/10.1111/ejed.12811

Urban, M., Děchtěrenko, F., Lukavský, J., Hrabalová, V., Svacha, F., Brom, C., & Urban, K. (2024). ChatGPT improves creative problem-solving performance in university students: An experimental study. *Computers & Education*, *215*(1), 15–31. https://doi.org/10.1016/j.compedu.2024.105031

Weisi, H., & Khaksar, Z. (2015). The effect of hemispheric dominance on Iranian EFL learners' creativity in writing. *International Journal of English and Education*, *4*(2), 383–397. https://doi.org/10.1371/journal.pone.00715

You, Y. L., Lin, A., Han, S. J., Chu, C. C., & Dai, C. Y. (2024). Using ChatGPT to assist writers with planning writing tasks in an EFL classroom. In F. M. Editor & S. S. Editor (Eds.), *Trust and inclusion in AI-mediated education: Where human learning meets learning machines* (pp. 235–260). Springer Nature Switzerland.

Zare, J., Al-Issa, A., & Ranjbaran Madiseh, F. (2025). Interacting with ChatGPT in essay writing: A study of L2 learners' task motivation. *ReCALL*, *2*(1), 1–18. https://doi.org/10.1017/S0958344025000035

Zhang, R., Zou, D., & Cheng, G. (2025). ChatGPT affordance for logic learning strategies and its usefulness for developing knowledge and quality of logic in English argumentative writing. *System*, *128*(1), 13–26. https://doi.org/10.1016/j.system.2024.103561